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Electronic Engineering

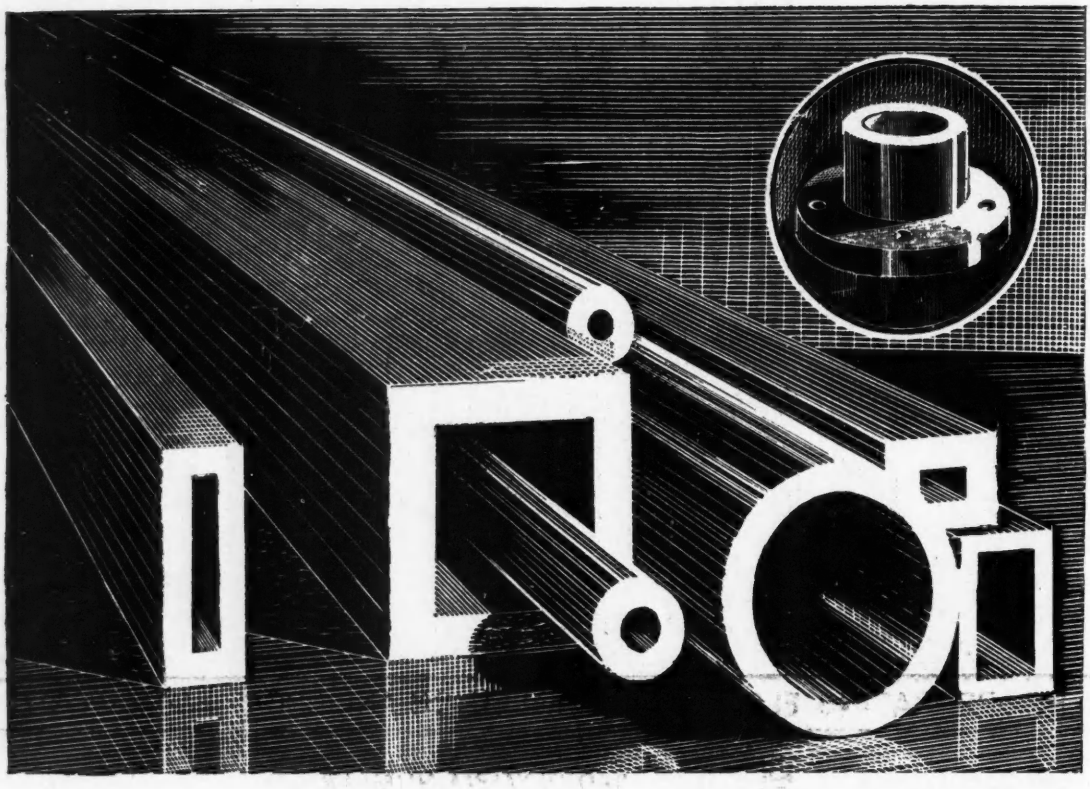
INCORPORATING ELECTRONICS, TELEVISION AND SHORT WAVE WORLD

PRINCIPAL CONTENTS

RADIOLYMPIA NUMBER

A High Quality Televisor — *Synopsis*
Radiolympia Preview
Plan for a Television Station
The Waveform Monitor — *Concluded*

2/- OCT., 1947



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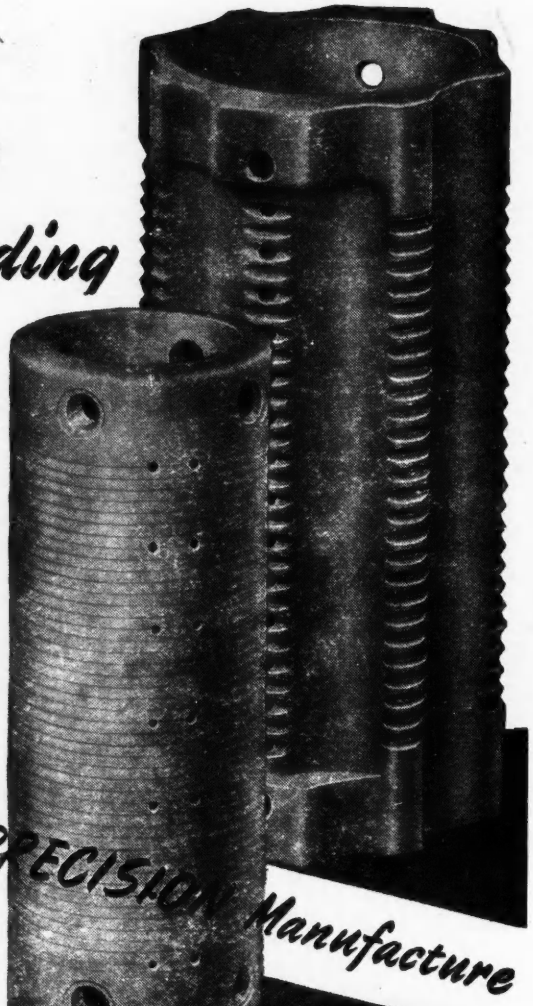

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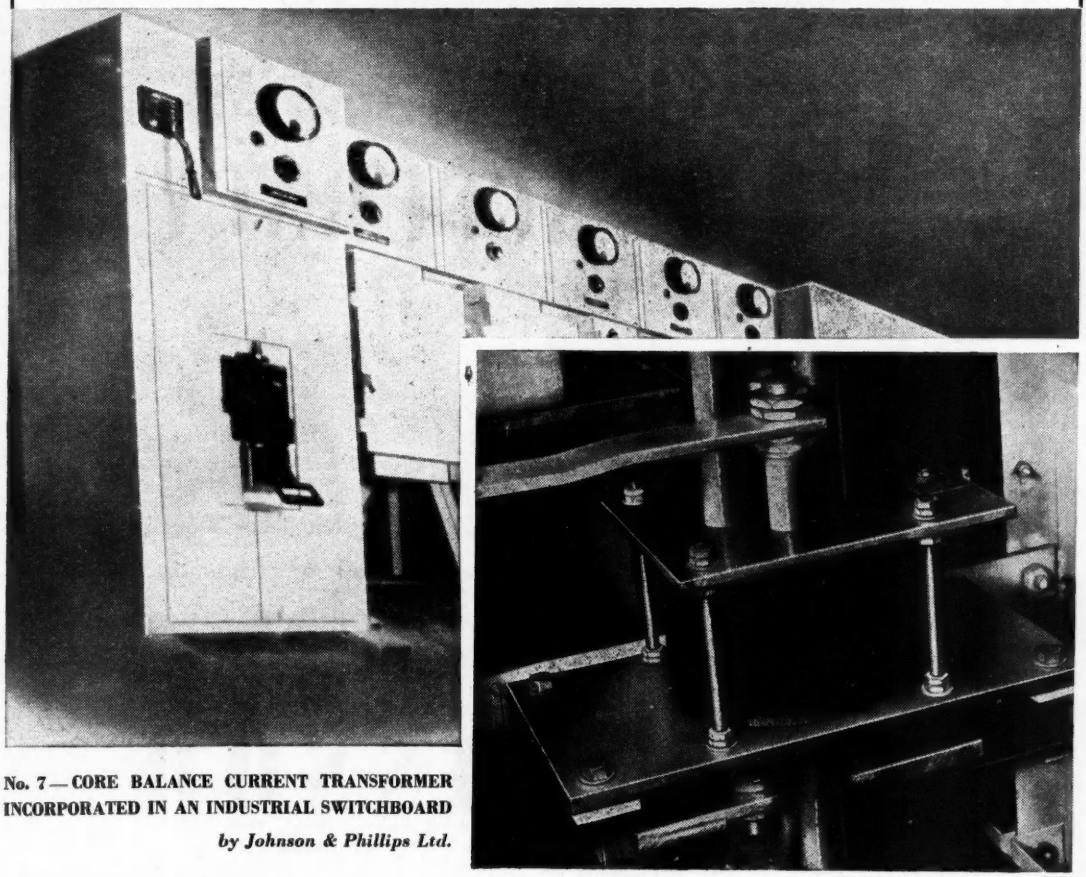

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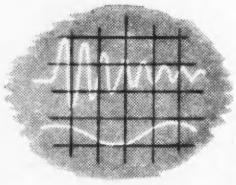

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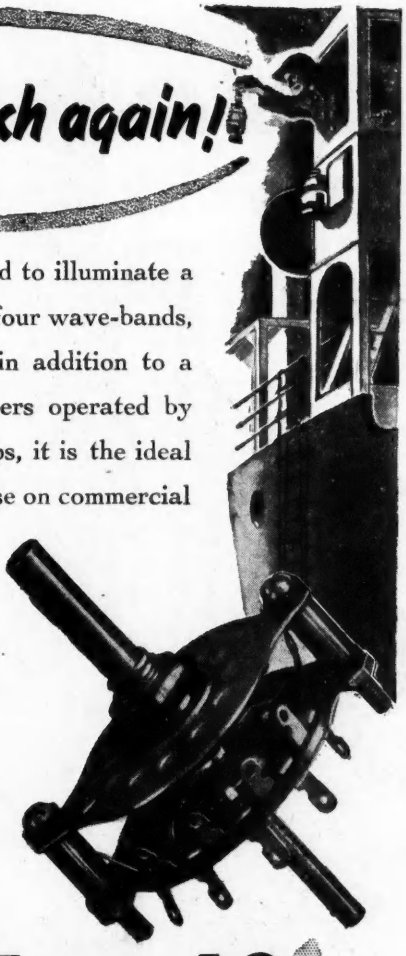

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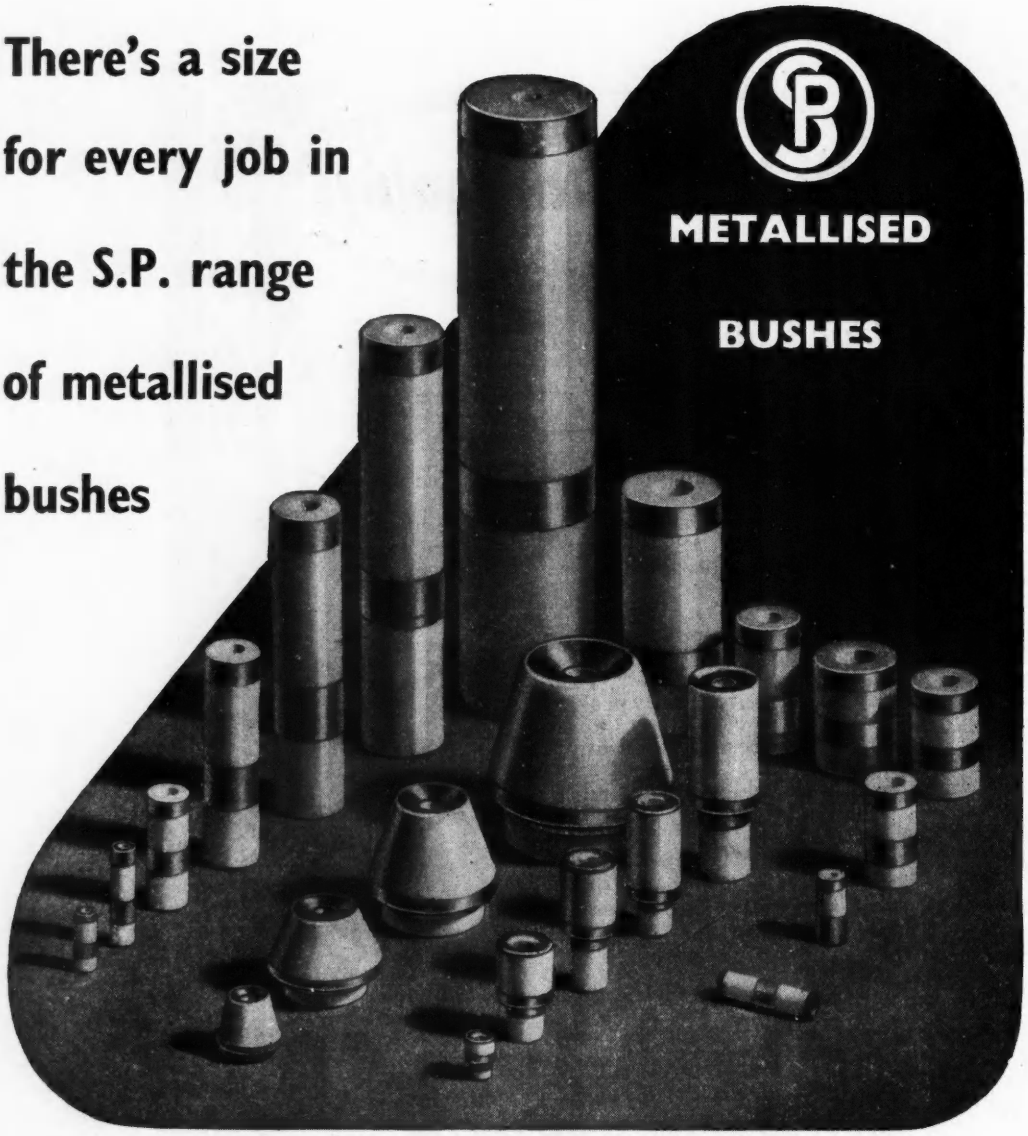

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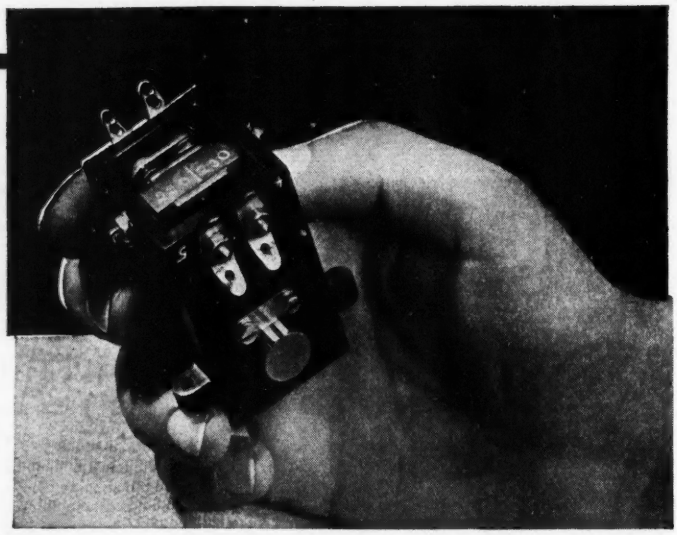

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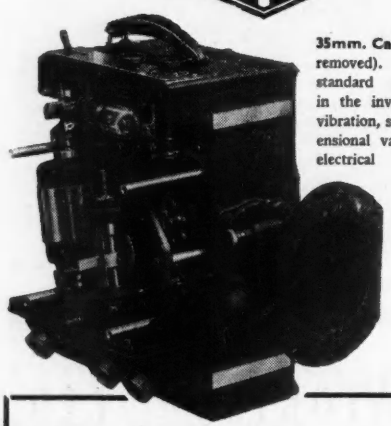

35mm. Camera (cover removed). Used with standard oscillograph, in the investigation of vibration, stresses, dimensional variations and electrical phenomena.

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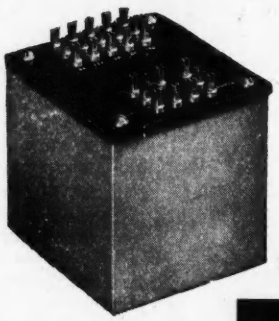

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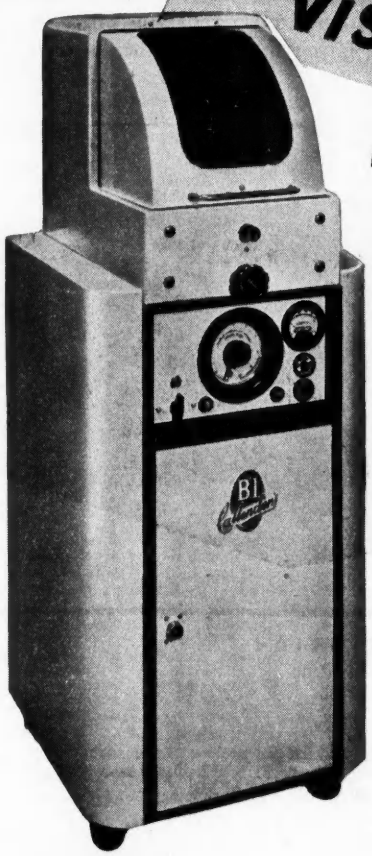

should inspect the wide range of high frequency heaters, welders and soldering machines on B.I. Callender's stand. These instruments are increasing production and reducing cost at many stages of radio and telecommunication equipment manufacture. Demonstrations will be given frequently each day throughout the exhibition.

Also on view will be the new B.I. Callender's all-wave anti-interference aerial, radio frequency cables, radio capacitors, polyethylene moulded connectors and a selection of solders and soldering fluxes.

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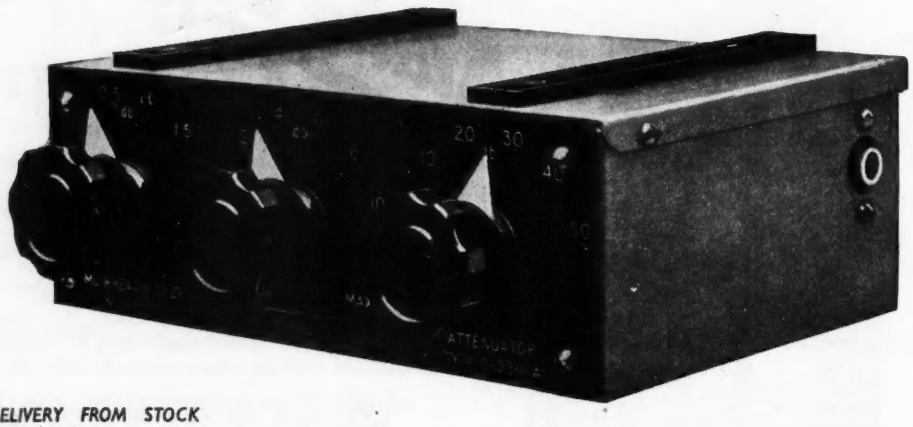

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TERMINATIONS :		Coaxial connectors.
INPUT :		3 volts maximum.
DIMENSIONS :		6½" × 2⅜" × 5½".
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Manufactured to a design of the Radio Branch of the Post Office Engineering Department.

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R.178	Secondary 300—0—300 v. 250 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps.	79/6
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R.187	Secondary 425—0—425 v. 180 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	78/6
R.190	Secondary 450—400—0—400—450 v. 180 mA ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 3.0 amps. 0—4—6.3 v. 3.0 amps. 0—4—6.3 v. 2.0 amps.	91/-
R.193	Secondary 450—400—0—400—450 v. 250 mA ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	107/6
R.195	Secondary 500—400—0—400—500 v. 180 mA ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 3.0 amps. 0—4—6.3 v. 3.0 amps.	89/6
R.188	Secondary 500—0—500 v. 250 mA ... ... 0—4—5 v v. 3.5 amps, 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	127/6
R.157	Secondary 1500—1250—0—1250—1500 v. 180 mA	165/-
R.159	1500—1250—0—1250—1500 v. 250 mA	225/-
R.162	2000—1750—0—1750—2000 v. 250 mA	315/-
L.415	0—4—5—6.3 v. 3.5 amps.	31/6
L.416	0—4—5—6.3 v. 6.0 amps.	34/-
L.460	4 v. 10 amps. C.T.	34/6
L.463	6.3 v. 8 amps. C.T.	36/-
L.466	7.5 v. 5 amps. C.T.	33/6
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H.T. supplies to television receivers.
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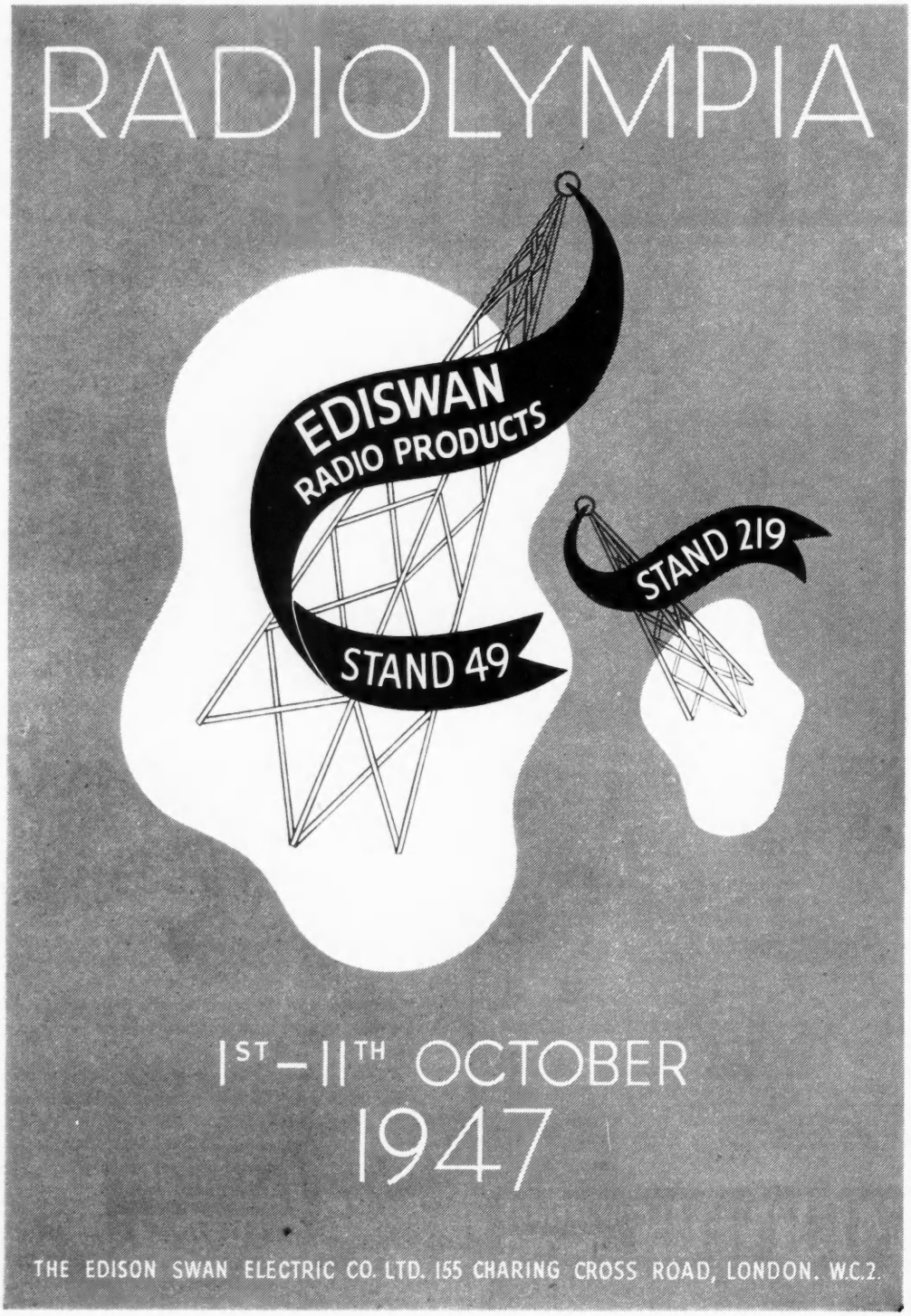
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MANAGING EDITOR G. PARR, M.I.E.E.

EDITORIAL, ADVERTISING AND PUBLISHING OFFICES, 28, ESSEX STREET, STRAND, W.C.2.

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Vol. XIX. No. 236 — October, 1947

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Home Built

TWENTY years ago, when J. L. Baird gave his first demonstration of practical television, the boom in amateur constructed radio was at its height. Blue prints appeared every week in the popular technical papers and the component makers worked overtime. The intricacies of superhets and Q.D.A.G.C. had not been thought of to worry the man in the home workshop, and when they did come it was inevitable that his interest should wane, particularly as he could buy a radio set for less cost in time and trouble and could get better results.

With television the urge to make found a new outlet, and within a few months of Baird's announcement several thousand enthusiasts had applied for licences to make experimental "televisors." Most of this enthusiasm evaporated when it was found that there was no programme on which to try out the sets, but the persistence of the few has been rewarded, in some cases by jobs in the industry that they helped to build.

Interest in home construction has never really died, and under present conditions, there is no reason why it should not revive. It has always been conceded that the amateur was a valuable contributor to progress in radio, and what he has done for sound broadcasting and communications he can very well do for television.

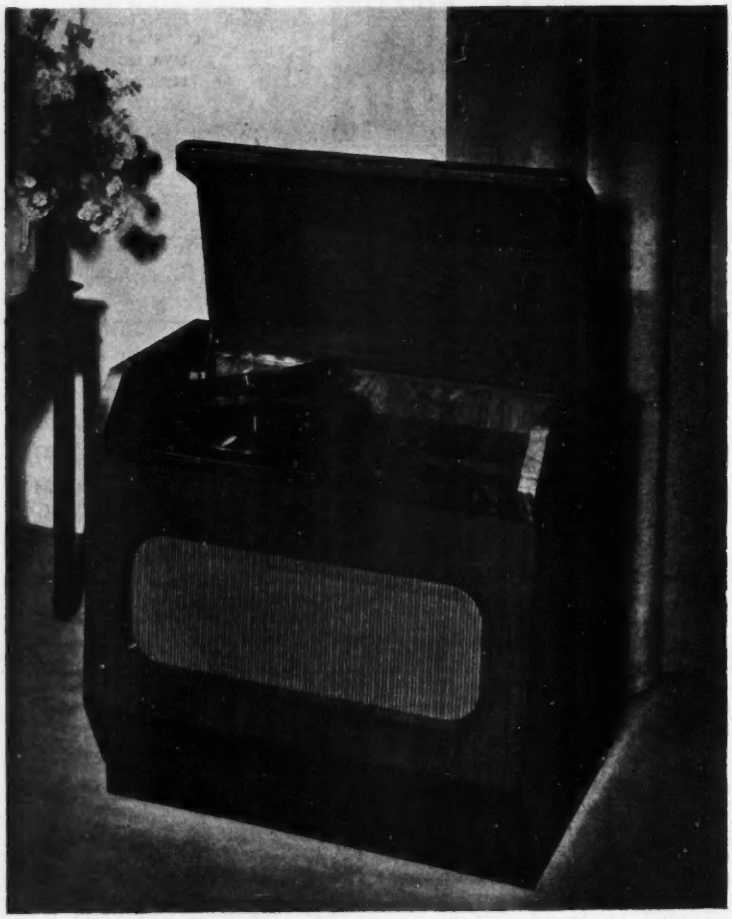
Many amateurs had experience of cathode-ray tubes during the war and would welcome the opportunity of putting that experience to use for their own pleasure. In the home constructed television receiver is this opportunity, and apart from the satisfaction of seeing a picture on a receiver constructed with one's own hands, there is the possibility that the owner may be able to make a contribution to the advancement of the science and the pleasure of many other people.

On another page will be found the synopsis of a television receiver for home construction which was designed for Electronic Engineering and demonstrated at a meeting of the Television Society by its designers, Messrs. W. I. Flach and N. H. Bentley, earlier in the year. This is not the age for extravagant claims, so the only comment made will be that it is every bit as good as the best and a great deal better than most.

Rather than issue the details in serial form and keep prospective builders on edge for some months, the design has been published in a booklet which will be on sale at the ELECTRONIC ENGINEERING stand at Radiolympia and from the offices of this journal. The receiver has been called the "Televisor" to commemorate the name coined by J. L. Baird and applied to his first television receiver.

In producing such a design, the amount of work which goes on behind the scenes is considerable, and it is a pleasure to acknowledge the interest and help which has been afforded by the makers of the various components, the editorial staff, and the blockmaker and printer, without whom it could not have been issued.

RADIOLYMPIA 1947



An example of the many finely made British radio receivers on show at Olympia
—Radiogram by Ferguson Radio.

THERE are over 200 exhibitors at the first post-war National Radio Exhibition at Olympia, held from October 1—11 (11 a.m. to 10 p.m.).

Even with the slight increase in size of this issue it has not been possible to do justice to the many new examples of development in the radio industry.

This report, based on advance information supplied by the exhibitors, has therefore concentrated on the electronic and telecommunications side. The exhibits are listed in order of Stands.

A list of manufacturers of domestic radio receivers is given on page 317 and for further details of these readers are asked to refer to the official catalogue.

It is hoped to give a full list of the television receivers exhibited in a later issue.

A. F. Bulgin Ltd. **Stand No. 3**

New items of special interest are:

(A) An entirely new range of press switches especially suitable for personal midget receivers. These are available in five types, for flush mounting. Operated by a polished plastic plunger which is actuated against a strong return spring. Also suitable for refrigerators, lobby lights, etc., where circuit is required on opening or closing of a lid, cover, door, etc.

(B) A new co-axial flex connector is now included in the Bulgin range and is designed for car radio uses. Also available for flush panel mounting. Types with integral fuse are also included (see p. 310).

(C) The range of toggle-switches now includes over 200 types. All types have been improved by the use of new methods of manufacture and by standardisation in the use of specialised raw materials.

(E) An entirely new range of moulded signal lampholders. These are of simple construction and have been designed to facilitate easy access to the lamp-bulb.

(F) For television requirements, a new mains connector (P.200) is available also 8 and 12 pin plugs and sockets. The P.200 fixes to the cabinet-back and breaks the mains supply on removal of the back thus ensuring absolute safety to the user.

The Telegraph Condenser Company Limited **Stand No. 5**

The transmitting mica condensers and high voltage paper smoothers will be of particular interest as will the specially designed ranges for television receivers which include the "Cathodray" pattern, in sealed moulded tubes, for working at 7 KV, 10 KV and 15 KV, and the latest design of "Micadisc" which is, in effect, a capacity bush with a top capacity of 500 pF, and is particularly useful for signal frequency circuits. Connecting lugs are provided for chassis mounting which forms one connexion. The other connexion is by a central eyelet which provides a convenient means for taking wires through the chassis and also for providing a fixed capacity to ground. "Micadiscs" will be featured in typical vision and sound chassis to show the efficient and workmanlike assemblies they provide.

Dynatron Radio Limited **Stand No. 6**

Special Measuring Equipment

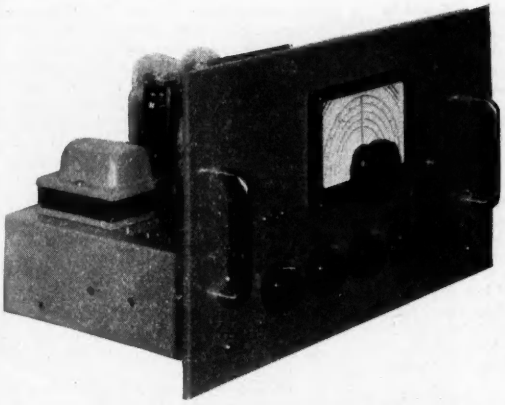
A series of special measuring equipments are shown similar to some made for the Ministry of Supply and primarily intended for Geiger counter measurements. They are all rack mounted and may be installed in a standard rack.

"Dynatron" scaling unit type SC200. A 22 valve electronic decimal counter, counting dead accurately up to 1,000,000. Operation from 5 volts pulse at maximum speed of 300 pulses per second. Price £110.

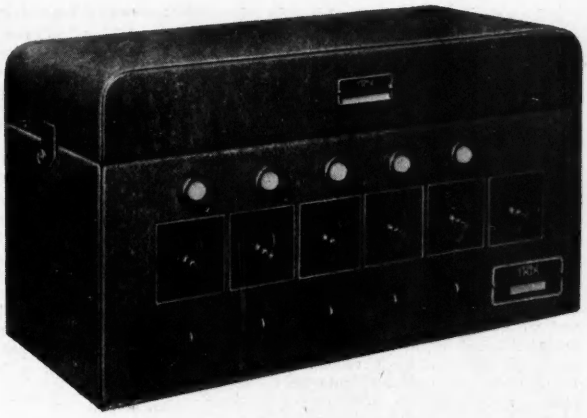
Probe unit for above, type PR200, to increase sensitivity. Price £6.

"Dynatron" Geiger power unit type P200. A highly stabilised source of E.H.T. for Geiger counter giving stable voltages up to 4,000 volts in four ranges. Price £75.

An oscilloscope for use with the above equipment is also available.



High quality local station receiver which has a straight line response with 2 dB from 40 to 9 Kc/s. with bass and treble controls. (see also p. 308.)
R. M. Electric Ltd.



Six-way Electronic Mixer
—Trix Electrical Co., Ltd.

Sound Amplifiers

The new " Dynatron " rack mounted sound amplifiers consist of a series of rack panel mounted amplifiers, tuners, mixers, gramophone units and distributing panels, together with cabinet type racks to Post Office front dimensions, enabling the dealer to order a sound amplifier system to meet his special requirements from virtually stock units.

Typical units from the range are :

Amplifier 30 watt, panel height 8¾ in. Cat. No. RA30. £35.

Mixer 4 valves, radio gramophone and microphone. Panel height 5¼ in. Cat. No. RMX1. £32.

Gramophone unit, automatic record changer, 10 in. or 12 in. records intermixed. Panel height 15¾ in. Cat. No. RARC. £20 10s.

Radio tuner unit, same features as T69A. Tuner. Panel height 10½ in. Cat. No. RT69. £41.

The cabinet racks are available separately and in much demand by research establishments, amateur transmitters and for all rack mounted test equipment (see also p. 309).

Decca Record Co. **Stand 14**

An outstanding exhibit on this Stand is the " Knightsbridge " record reproducer, which incorporates six speakers and retails at £403 5s.

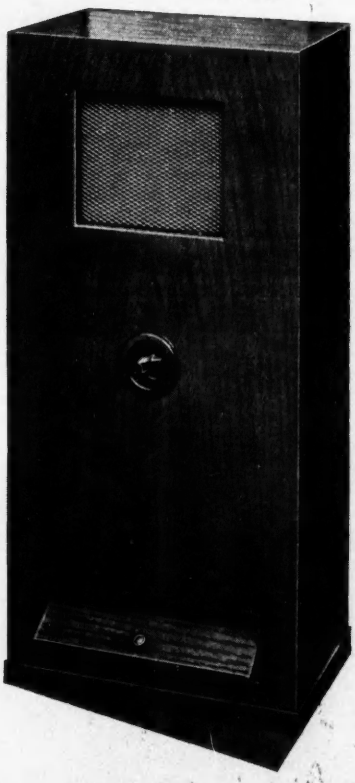
There is a new type of portable record-player with a light-weight needle armature sapphire pointed pickup. The needle armature pickup is now available for public sale and to manufacturers for use in their own instruments.

Tannoy Ltd. **Stand 17**

Two new gramophone pickups will be displayed; one takes conventional gramophone needles, which are held with a spring-locking device, has a response free from any objectionable resonances, and is substantially level up to 7,000 c/s. The second model takes miniature gramophone needles and is intended for use in installations where the very highest fidelity is required. This pickup has a frequency response which is level to 10,000 c/s.

To cater for the needs of high fidelity reproduction, a 15-in. single cone unit is available, which has a frequency response free from objectionable resonances, substantially level between 60 and 8,000 c/s. Also available for the first time is the Tannoy concentric dual loudspeaker system, comprising a small diaphragm horn loaded unit, a large diaphragm cone unit, and a suitable dividing network, all in one assembly, little larger than a conventional heavy duty single cone unit. The frequency response is substantially level between 30 and 12,000 c/s.

The Tannoy Recording Console enables disk recordings of a quality superior to most commercial recordings to be made, at home or in the private studio. The recording characteristic is substantially level between 60 and 8,000 c/s.



" Varitone " loudspeaker cabinet fitted with an 8 in. unit. Phase in version and air column bring the bass response down to about 45 cycles/sec. The port is fitted with a door which can be closed for damping the resonance for reproduction of speech.
—Wharfedale Wireless Works.

Steatite & Porcelain Products Ltd. **Stand No. 18**

A wide range of insulator types used in the telecommunication industry is displayed, made from the low-loss steatite-base material " Frequentite." Specially featured are insulators to very close dimensional limits, such as ground condenser spindles, and ground-thread coil formers.

The exhibit includes an extensive standard range of metallised insulators for hermetic seals, together with other types produced to special requirements.

Titania ceramics for condenser dielectrics are also shown.

Trix Electrical Co. Ltd. **Stand 20**

The " Trixonic " concert reproducer contains the latest quality amplifier model T614 with independent tone control circuits for the bass, middle, and top register. The unit will provide 16 W undistorted output, and is fitted wih record changer and permanent sapphire needle in the pickup. There are two speakers (12 in.) and a radio receiver unit for three wavebands (see also photograph above).

New London Electron Works Ltd. **Stand 22**

A new " electron " rod aerial specially designed to improve reception where it is impossible to erect a conventional aerial.

Price 21s. including 25 ft. of lead-in wire and fittings.

Also available: Telephone wire, 22 s.w.g. in single, twin, 3- and 4-way. Flame and moth-proof insulation.

Multicore Solders Limited **Stand No. 23**

For factories in radio and other industries where solder is used in production processes, Multicore supply their product in five standard alloys having tin and lead percentages respectively of 60/40, 45/55, 40/60, 30/70 and 20/80 and in nine gauges between 10 and 22 S.W.G. inclusive. Other alloys and gauges can be supplied to special order.

Features of particular interest to research and works engineers, include the specially designed hot plate, of which similar models are being shown at the Utrecht and Zurich Fairs, employed to demonstrate the fluxing ability and speed of soldering of Ersin Multicore Solder. Other equipment shows how bit temperatures of soldering irons can be determined while joints are actually being made.

Garrard Eng. & Mfg. Co. Ltd. **Stand 24**

The well-known range of Garrard gramophone motors is shown, with the automatic record-changer, a complete unit for incorporation in radiograms. The Garrard pick-up is available for individual sale in addition to quantity supply for manufacturers.

Sydney S. Bird & Sons (Cyldon) **Stand 31**

A complete range of variable precision capacitors, together with new dual type for inclusion in a ¾ in. square can.

A novelty is the Prestacon constructional press for model-making, which has applications to the radio industry in the making of small metal parts, brackets, etc., in prototype construction.

Electrothermal Engineering Ltd. **Stand 32**

In addition to the range of valve retainers and asbestos-insulated line cords, a new range of thermostatic switches, cord switches, and series-parallel cord switches will be shown for the first time (see p. 310).

Belling Lee Ltd. **Stand No. 33**

The new Belling Lee Skyrod will be 18 ft long, in three sections, of high tensile alloy, for chimney mounting. Instead of one set of transformers for the "Skyrod" and another for the "Eliminoise," there will be one set only, which will normally be used with the "Skyrod," but may also be used with a horizontal aerial, or attached to the cross bar of a television dipole (Belling Lee U.K. patent No. 520628) to enable the reflector to be used as an anti-interference aerial.

Also shown is a full range of television aerials including the comparatively new indoor television aerial for attic or loft. This is intended for districts where field strength is strong. It has very distinct minima, which can be used against interference. Can be used indoors, or is supplied with metal mast and lashings for chimney mounting (see also p. 312).

Westinghouse Brake & Signal Co. Ltd. **Stand No. 34**

The Westinghouse exhibit will be devoted not only to new products but also to improvements that have taken place since the last radio exhibition.

The chief alteration to pre-war technique is the use of "Westalite" instead of copper-oxide rectifiers for all power uses, the main advantages of the newer types being that their characteristics remain stable over prolonged periods of idleness, that they may be operated up to a total temperature of 70° C., they are smaller and lighter and have a much higher efficiency than any other metal rectifier.

"Double-voltage" Westalite units are the latest advance. These units have an efficiency of 90 per cent., a size and weight for a given output one half of that for a standard Westalite rectifier and their range has been extended to include a group of rectifiers suitable for H.T. supplies to A.C. and A.C./D.C. receivers and battery eliminators, and for loudspeaker field excitation.

Collaro Ltd. **Stand 35**

This firm's latest production is the "Microgram," a portable electric gramophone of high quality giving 2½ watts output. De luxe model, 19 guineas, plus purchase tax.

Also shown are the AC.47 induction motor, automatic stop operating from the pickup, and auto record changer.

Erie Resistor Co. **Stand No. 41**

Included in the Erie exhibits are a new feed-through condenser and the first of a new series of double cup Ceramicons, together with a wide range of ceramic condensers and carbon products for special applications.

The McMurdo Instrument Co. Ltd. **Stand 42**

McMurdo show a complete range of McMurdo amphenol valveholders. These include bakelite moulded and ceramic types and the range includes valveholders for B8A and B7G bases. A base board mounting octal valveholder is also available.

A variety of other impression and injection mouldings are also shown.

The firm also manufactures three types of amplifier; a 20 watt A.C./D.C. type having high gain and with high and low impedance inputs; a 3 watt type operated from a 6 volt car battery and a 15 watt 12 valve amplifier intended for the highest possible quality. This amplifier is in two units and includes an oscillator operating at high frequency for supplying the heaters of the first three valves to reduce hum.

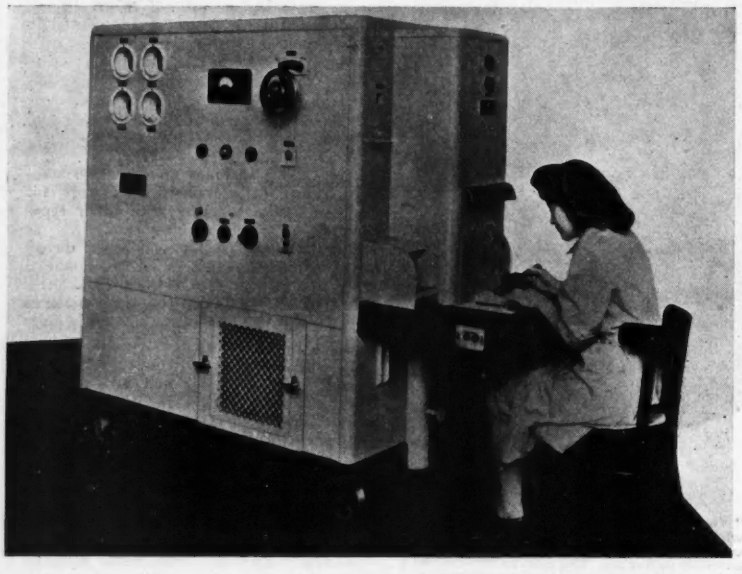
R. M. Electric Ltd. **Stand No. 51**

I.F. transformer, type I.F.T.67 of an unusual design. Its construction is similar to a modern canned electrolytic condenser, the can being 1⅜ in. diameter by 2¼ in. The coils are wound on a moulded former which carries the four tags, two silvered mica condensers, also an internal thread which accommodates the threaded iron cores. Trimming is performed at the top and bottom of the transformer.

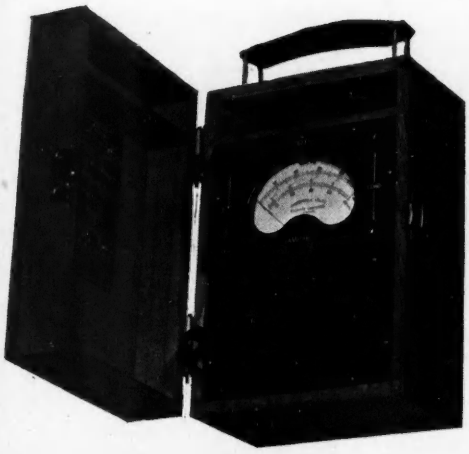
The main object of this construction is to standardise fixing methods of components and allow easy replacement as it is secured to the chassis by the standard electrolytic condenser fixing clip (see also photograph p. 307).

Haynes Radio Ltd. **Stand 53**

Television components. Scanning and focus coils, line output transformers and E.H.T. transformers up to 7,000 V D.C. output in hermetically sealed containers.

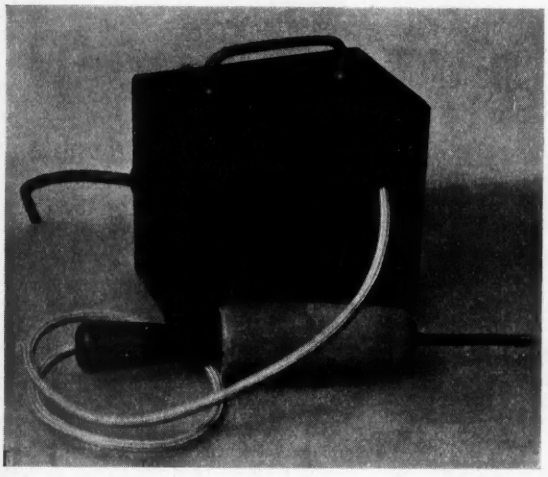


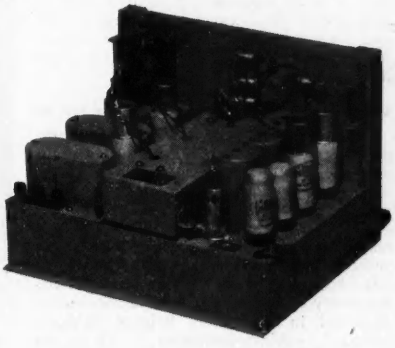
5 KW. high frequency valve generator for industrial heating processes (see also p. 314)
—The General Electric Co., Ltd.



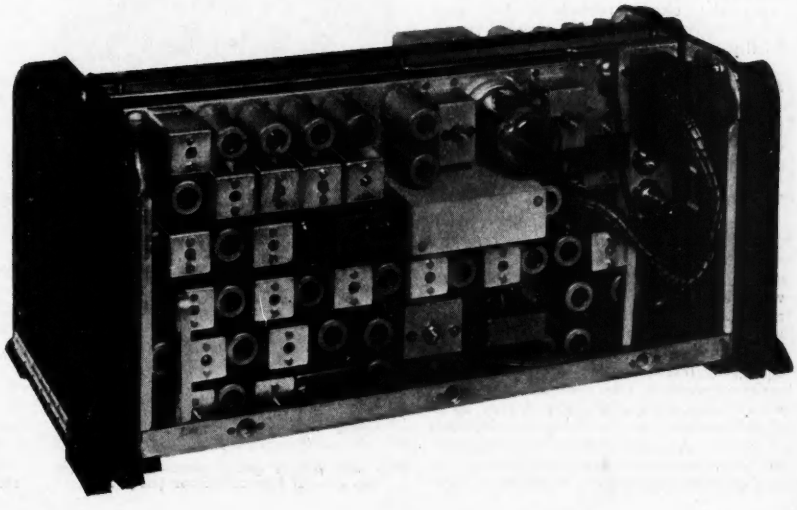
Left: **"Vampire" Test Meter, reading volts, amps (4 ranges) and watts.** (See also p. 311). —*Everett, Edgcumbe*

Right: **Electronic Testmeter with an input resistance of 111 megohms.** (See p. 311). —*Automatic Coil Winder.*



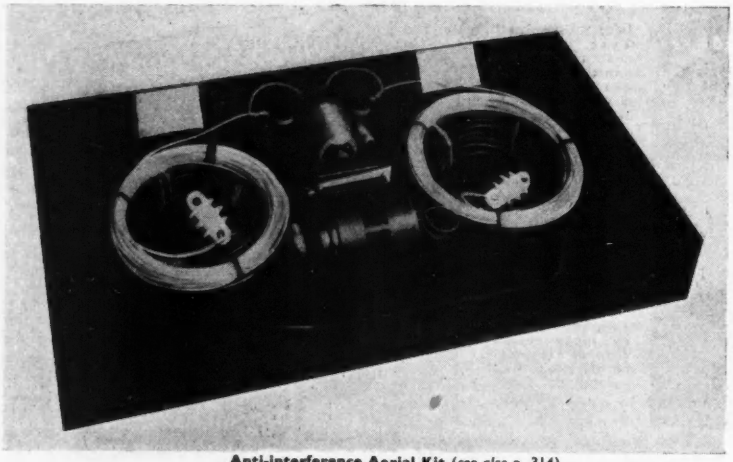


Above: **Ferranti "Tesvac" Unit, giving 4 Mc/s H.F. voltage for vacuum testing.** (See p. 314).



Centre right: **Tuner Unit from the Dynatron range. This is available in chassis form for fitting in existing cabinets.** (See p. 306).

Lower right: **Interior of the transmitter and receiver chassis of the new G.E.C. single unit F.M. Mobile set.** (See also p. 314).



Anti-interference Aerial Kit (*see also* p. 314)
—*B.I. Callender's Cables.*

3. Transformers and chokes of all types for every requirement including some of the new " Crystalloy " core form of construction. A booklet is available of special interest to the transmitting amateur dealing with valve and transformer applications and showing circuits and constructional features for transmitters up to 150 watt input power.

Vitavox Ltd. **Stand No. 54**

Among exhibits is the Vitavox bitone reproducer which has an attractive appearance that matches its performance. A multi-cellular horn and moving coil pressure unit ensure perfect audibility at high audio frequencies, and a 12 in. moving coil cone type loudspeaker, operated in a vented enclosure, reproduces low frequencies. A cross-over filter network divides the frequency spectrum between the two units. Mounted in a smartly finished polished walnut cabinet—veneered oak and mahogany cabinets are also available to order—the bitone reproducer has been scientifically constructed to give maximum fidelity under auditorium conditions.

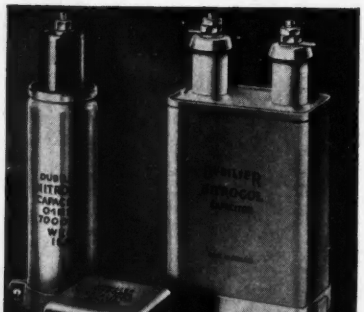
Alfred Imhof Ltd. **Stand 62**

A range of gramophone accessories, including a new record rack, and a variety of well-finished metal boxes and cases for apparatus in black and colours.

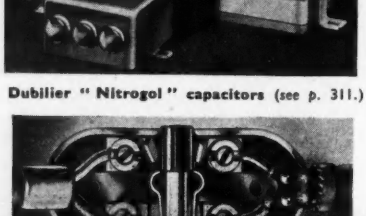
The Plessey Co. Ltd. **Stand No. 65**

Components being shown include, trimmers, chokes electrolytic condensers, drive mechanisms, variable condensers, iron cores, switches, transformers, vibrators, valve holders, a range of miniatures and a set of television components including scanning coil assemblies, focus coils, line transformers, frame transformers and squegging transformers.

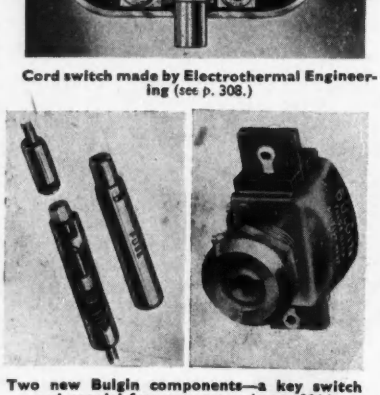
Of interest is the new Plessey mixed record auto-changer which will play up to eight records, 10 in. and 12 in. (see p. 313). An exceptionally small number of parts has been used in the design of this auto-changer and it is therefore light in weight. During playing, any record may be rejected and any record repeated at will. Following the rejection of a record, the mechanism reverts automatically to normal single playing and further repeats may be made by resetting the " repeat " button. A special clutch device has been incorporated to prevent damage to the pick-up arm mechanism, if it is mishandled.



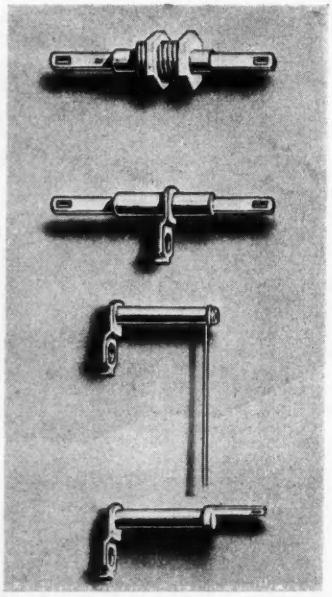
Dubilier " Nitrogol " capacitors (*see* p. 311.)



Cord switch made by Electrothermal Engineering (*see* p. 308.)



Two new Bulgin components—a key switch and coaxial fuse connector (*see* p. 306.)



Ceramic lead-through and by-pass capacitors. (*See* p. 312). —*United Insulators*

Speakers

Speakers are fully dustproof and an aluminium voice coil former is used. Owing to the adoption of a centre pole magnet on PM speakers there is no external magnetic field so the speakers may be installed in television receivers in close proximity to the C.R. tube, without distortion.

Vibrators

Plessey non-synchronous vibrators have a time efficiency of 90 per cent.

The tuned reed principle is employed whereby the reed arms develop independent oscillations from the reed and are controlled to a frequency of three times that of the reed frequency (115 c/s.). This results in an additional source of contact pressure. Since the third oscillation of the reed arm is not fully developed when contact is made with the side arm, a combined cushioned " make " action results and contact chatter is eliminated.

The Mullard Wireless Service Co. Ltd.
Stand Nos. 71, 112 & 214

Measuring Instruments

The Mullard range of measuring instruments includes :

A cathode ray tube unit type B100 consisting of a small cathode ray tube and self-contained power supply.

A cathode ray oscillograph (type E800) designed for low-frequency investigations.

A cathode ray oscillograph (type E805) designed for the investigations of high-frequency phenomena.

A resistance and capacitance bridge with " magic eye " null indicator. Also conductivity cell to enable the bridge to be used for determining the conductivities of solutions.

A moisture meter for measuring the moisture content of grain. The range is completed by an example of a unique potentiometric titration apparatus and an audio frequency oscillator (type E810).

Radio Valves (Technical Services and Publications)

Technical inquiries regarding valves exhibited will be dealt with by representatives of the Mullard Technical Service Department at a special inquiry bureau set up for the purpose. A complete selection of current technical literature (including the Mullard Technical Handbook) is available and inquiries are invited.

Lecturers and students will be interested in a new educational service for schools and colleges which makes use of film strips and specially prepared lecture notes.

Salford Electrical Instruments Ltd. **Stand No. 75**

Miniature Crystal Calibrator

A simple but accurate instrument for the calibration or alignment of radio receivers and similar apparatus. Uses a quartz-crystal controlled oscillator circuit designed to produce a large number of harmonics of the fundamental frequency (100 Kc/s.) and incorporates optional audio frequency modulation. The useful range of available harmonics extends to about 30 Mc/s.

Toroidal Cores and Coils

A selection from a wide range of toroidal iron-dust cores together with typical coils will be shown. The cores are available in various sizes and permeabilities with or without windings produced to customers' own specifications.

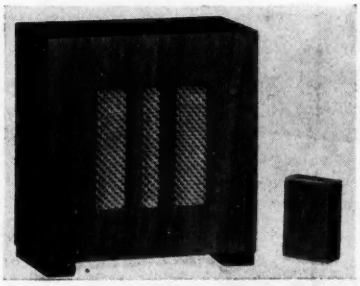
Quartz Crystals

A selection including typical units for frequencies from 4 Kc/s. to 15 Mc/s.; most of the new types are available in evacuated holders. A typical unit of general utility is the type JCF/200, frequency 100 Kc/s; this has an accuracy of frequency adjustment of 0.01 per cent. as standard but higher accuracies can be provided if required.

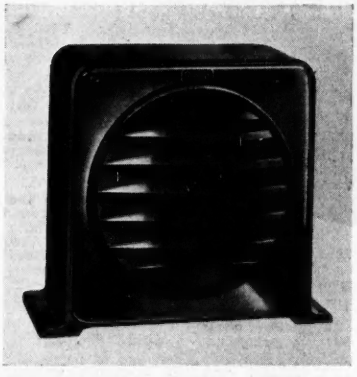
Everett, Edgcumbe & Co. Ltd. **Stand No. 76**

The Hum Metrohm is a 500 volt insulation tester and earth circuit conductivity tester combined. The 500 volt supply is obtained by means of a battery-buzzer-transformer-rectifier combination, the output of which has far less ripple than the hand generator pattern, making it especially suitable for condenser testing.

The educational valve tester is designed to save laboratory time previously spent in wiring up valve circuit hook-ups with the consequent risk of damage to valve and meters. A book supplied with the instrument gives particulars of fifty elementary experiments suited to the first years of national certificate courses in technical colleges. A feature is a mimic diagram which eliminates the " box of tricks " aspect that a power pack and nine moving coil indicators might create. The controls and meters all register on the diagram which the student can copy into his laboratory notebook.



This new Goodmans' extension speaker is shown with a matchbox for comparison. It has a power rating of 2 W in spite of its size.



One of the variety of speakers exhibited by British Rola Ltd. These extension speakers are in coloured cabinets and look very attractive.

The Vampire (volts, amps, power) is an entirely new rectifier operated A.C. test set which provides four ranges of current and power and a single range of voltage. A patented circuit is included for the watt-meter readings. The principle employed can be used for power measurements over a wide range of frequency although the instrument displayed is for power frequencies only (see also p. 309).

Dubilier Condenser Co. (1925) Ltd. **Stand 80**

Nitrogol Capacitors

This technique employs an impregnant of mineral base, subjected to a special process. It combines the superior electrical performance at high temperatures of high viscosity mineral jellies, with all the advantages of the finest mineral oils (see p 310).

Precision Wire-Wound Resistors

The construction of these resistors comprises a mechanically strong, high insulation slotted ceramic former of low coefficient of expansion, wound in alternate directions with enamelled resistance wire of not less than 0.0014 in diameter (see p. 314).

Truvox Engineering Co. **Stand No. 81**

" Wafer " Permanent Magnet Loudspeakers

In the Truvox " Wafer " speakers, a fresh approach to the problem of speaker size and weight has resulted in a speaker of only half the usual depth. The magnet, is actually the core of the speaker enclosed within the depth of the cone, with the magnetic circuit completed by the speaker chassis itself. Fidelity of response is excellent and sensitivity is comparable to speakers of orthodox design. The 2½ in. model has great usefulness as a moving coil microphone. The almost complete absence of an external field, which is one of the outstanding characteristics of the range, makes the 6½ in. model of great interest to television enthusiasts.

Provisional prices are:

Model BS1250, 2½ in., 22s. 6d.; model BS1350, 3½ in., 23s. 6d.; model BS1500, 5 in., 24s.; model BS1650, 6½ in., 25s.

Supplies for retail sale beginning in December.

Goodmans Industries Ltd. **Stand 87**

This company are concentrating mainly on a range of high quality cabinet speakers, which include a small table model reflex cabinet fitted with a dustproof 8 in. unit of 3 W power handing capacity.

The largest cabinet incorporates a twin diaphragm 12 in. unit rated at 12 W peak power. The frequency range of the models is exceptionally wide. Heavy-duty reproducers of 15 in. and 18 in. diameter are also available. A diffuser type has been developed for halls or factory assembly shops and has a full 360° coverage. A new extension speaker is shown in the figure with a matchbox for comparison.

A. H. Hunt Ltd. **Stand 88**

In addition to a very wide range of capacitors—paper, electrolytic, mica and trimmer types—this company have recently developed metallised paper miniature capacitors in both the A.C. and D.C. types.

Automatic Coil Winder & Electrical Equipment Co. Ltd. **Stand 113**

Several newer instruments coming into production are shown. They are:

Electronic Testmeter

This instrument has been developed to meet the demand for an instrument of laboratory sensitivity built in a robust and portable form, for use in conjunction with electronic and other apparatus where it is imperative that the instrument should present a negligible loading factor upon the circuit under test.

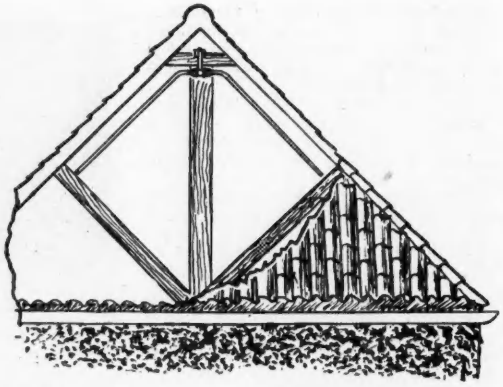
The instrument will present a maximum input resistance of 111.1MΩ., and will give full scale readings as follows:—

D.C. 250 mV—10,000 V.

A.C. IV—2,500 V. (with negligible error up to 2 Mc/s. and IV—250 V to 200 Mc/s. (see also p. 309).

Valve Characteristic Meter

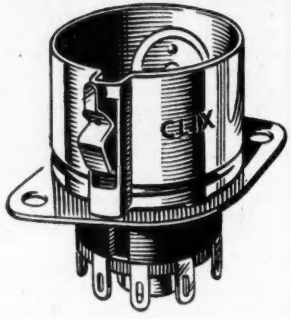
This meter has been developed to meet the more exacting requirements of engineers and research establishments who require to reproduce any or all of the wide family of characteristics of a valve. It will compensate for line voltage fluctua-



Left: **The Taylor Type 130A insulation checker** (see *col.* 1.)

Right: **Sketch of the Belling-Lee inverted-V television aerial for attic mounting within 5 mile radius of A.P.** (see *p.* 308.)

Drawing of the new B.8A valveholder made by Clix.
—British Mechanical Productions.



tions, produce all the necessary data to enable mutual conductance Ia Va, Ia Vg, Ia Vs, etc., curves to be drawn, cathode/heater insulation to be measured with the heater hot, a gas check being incorporated.

Wide Range Signal Generator

This is an inexpensive R.F. generator of remarkably wide range and accuracy of performance. Six ranges cover fundamental frequencies of 50 Kc/s.-50 Mc/s., turret coil switching being employed. A modified Colpitts oscillator employing an H.F. pentode with amplitude limiting circuits gives a pure waveform and constant high level signal into the attenuator over the full frequency range.

The frequency calibration is accurate to within plus or minus 1 per cent. of the readings given upon a large clearly marked dial, the total calibrated scale length being approximately 45 in.

Taylor Electrical Instruments Ltd. Stand 119

Seven instruments are of new design:

1. Model 20A circuit analyser. This instrument operates from A.C. mains, and is designed for checking radio receivers by following the signal throughout the receiver. Price £15 15s.

2. Model 30A. This is a cathode ray oscillograph operating from A.C. mains, and uses a 3½ in. tube. The instrument is provided with an amplifier for the vertical input and a horizontal linear time base is provided covering the range from 10-10,000 cycles. The price of this instrument is £27 10s.

3. Model 70A. A 50-range universal meter covering up to 1,000 volts A.C or D.C. at 1,000 ohms per volt. £10 10s.

4. Model 75A. Similar to Taylor model 70A, except that all voltage ranges are at 20,000 ohms per volt A.C. or D.C. and resistance measurements on this instrument are up to 10 megohms with internal battery. Price £14 14s.

5. Model 110B. This is a resistance and capacity bridge, operated from A.C. mains giving accurate readings of resistance and capacity. There are seven resistance ranges covering from 0.1 ohm to 12 megohms. There are also seven capacity ranges covering from .00001 to 1,200 Mfd. The price of this instrument is £14 14s.

6. Model 130A. An A.C. mains operated insulation and continuity checker. The meter has two scales, one reading from 0-100,000 ohms having a centre scale reading approximately 1,000 ohms, and a second scale reading from 0-1,000 megohms with a centre scale reading approximately 10 megohms.

7. Model 290A. A very high range megohmmeter covering from 20,000 ohms to 50,000 megohms in four ranges. The instrument is A.C. mains operated, and has a 4 in. meter scale calibrated 0-50 megohms, and the multiplier switch gives a choice of four ranges X1, X10, X100, X1,000 respectively. The instrument is mounted on a bakelite panel, and is fitted in an oak case. The price of this instrument is £29. Hire purchase terms may be applied to all instruments in the Taylor range.

Wright & Weaire Ltd. Stand 125

Coils & R.F. Components

The type "P" coils give complete coverage from 12-2,000 metres for aerial, H.F., and oscillator tuned circuits. The coil packs are of two types, a constructors' version and a new manufacurers' version of novel construction. In addition there are permeability tuners for aerial and oscillator circuits.

United Insulator Co. Ltd. Stand No. 126

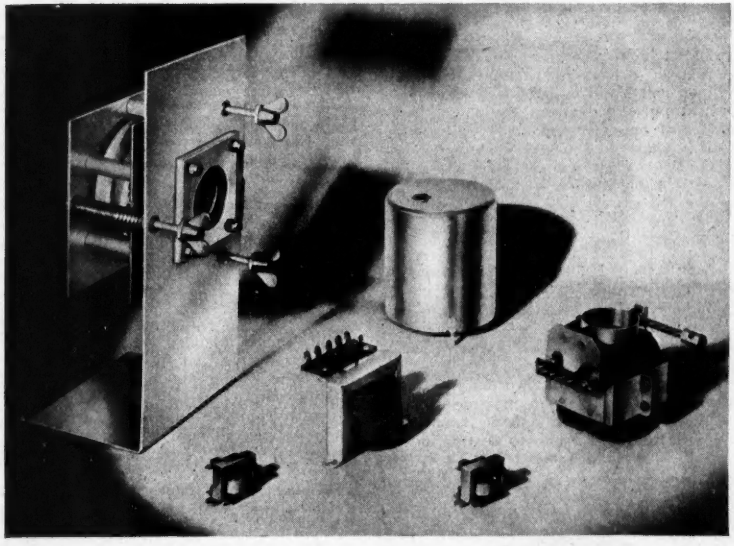
Several components never shown before in this country:

1. Silvered Mica Twin Capacitor intended for use as an end plate or base on I.F. transformer (Patent Applied For)

Two capacitors of any desired value up to 200pF are built into an I.F. transformer end plate thus reducing the number of components from three (transformer base and two capacitors) to one. Two sizes will be available, one for miniature I.F. transformers ⅝ in. square and one for standard size I.F. transformers 1⅜ in. square.

2. Ceramic Wafer Capacitor (Patent Applied For)

The design of this Ceramic capacitor which consists of a small flat plate, has departed completely from the traditional tubular, disc or hat shape. The present range covers capacitances from 10pF-100pF. Wafer capacitors are rigid in design, stable in electrical performance and inexpensive.



A set of Plessey television components : scanning coil assembly, frame and line transformers, and focus coil (left).

3. Ceramic High Voltage Lead-Through-Capacitor

This component has been specially designed for lead-through and by-passing applications where appreciable amounts of H.F. power have to be handled. (See also p. 310.)

Clix (British Mechanical Productions Ltd.) Stand 127

An entire range of British and American valve holders, including the new British B types, and several new additions to the range.

A new M.E.S. lampholder designed on a novel principle.

Masteradio Ltd. Stand 130

Car Radio Accessories

The range of "Selector" aerials now available includes roof aerials, under-car and telescopic aerials for car radio.

A complete range of accessories for the installation of car radio receivers is available, including suppressor resistor and capacitor, battery and aerial connectors, lead-in, and vibrators.

Vibrators

The standard range of Vibratorpacks covers four types :

a. High output (300 V 100 mA) self-rectifying.

b. As above with valve rectification, the input being completely isolated from the output.

c. Type embodying selector switch which varies the output in four steps of 25 V each.

d. A new type giving noise-free operation on sensitive receivers. Inputs 6 or 12 V. Outputs up to 20 W.

Non-standard Vibratorpacks can also be designed to customers' own requirements.

British Tungsram Radio Works Ltd. Stand 132

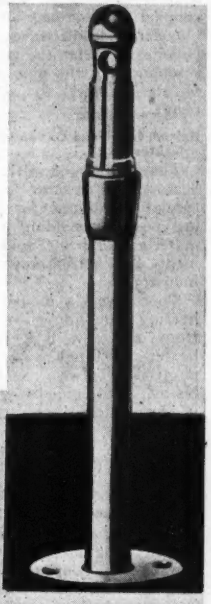
Pressed Glass Base Valves

In keeping with modern development the Tungsram organisation is working on new designs of valves with more efficient operating characteristics and future ranges will include all-glass valves fitted with the new standard bases.

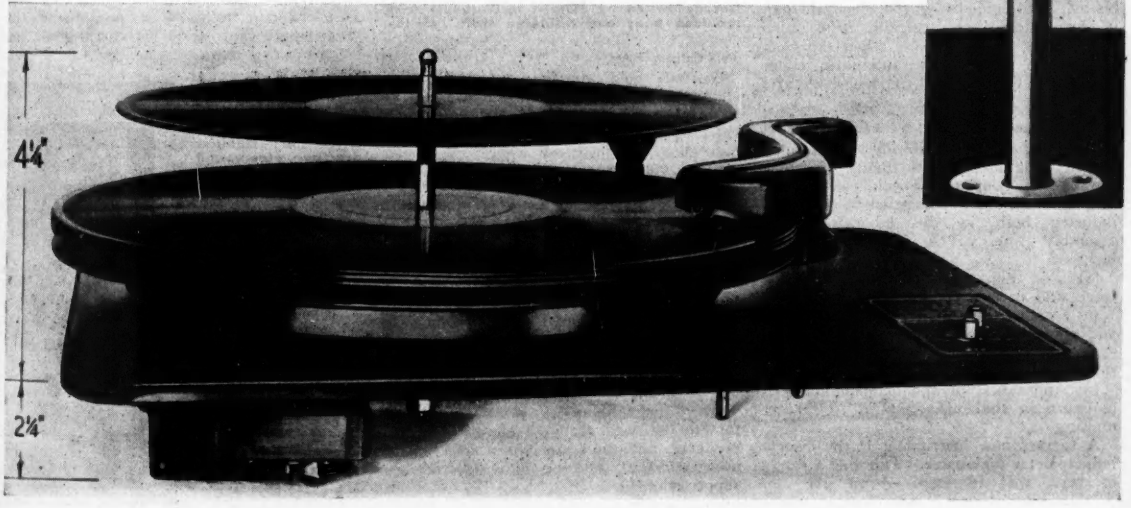
Tenaplas Ltd. Stand No. 133

A selection from a very wide range of thermoplastic extrusions in sizes from less than 1 mm. to 6 in. diameter.

The material mainly used is polyvinyl chloride, but in some cases polythene is more suitable, as the latter's electrical properties are almost amazing. Dielectric constant, breakdown voltage and power



Automatic record changer by the Plessey Co. The close-up shows the centre spindle with a collapsible projection on which the records are placed. Each record is released automatically in turn. Stand 65.



factors are extremely good and are maintained at very high frequencies. Polythene or polymerised ethylene is a novelty as far as extrusion is concerned, but Tenaplas have perfected the technique.

Tucker Eyelet Co. **Stand 134**

All types of eyelets, soldering tags, eyeletted wires, fuse caps, carbon caps, and battery sockets. "Tucker eyelets are used by practically every radio manufacturer in the United Kingdom."

Long & Hambly **Stand 146**

A complete range of rubber masks for television tubes, giving an oblong viewing area of the correct dimensions. Masks can also be made to customers special design. In addition this company supply valve retaining straps of rubber with a high breaking strain and rubber mounted blocks for anti-microphonic valve mounting.

Acoustical Manufacturing Co. Ltd. **Stand 147**

Among a wide range of public address equipment on display on the stand is the new concert labyrinth loudspeaker, specially designed with a new form of loading. The inside of the cabinet is shaped to form a folded tube or pipe, coupled to the back of the driving unit. Quarter and half wave pipe resonances are balanced so that the resonances and anti-resonances of the pipe combine with those of the cabinet to achieve the desired result.

British Insulated Callender's Cables Ltd. **Stand 200**

The range of B.I. Callender's H.F. heaters on show comprises models specially designed for pre-heating moulding powder, welding thermoplastic sheet materials and for soldering. All instruments find a wide application in the radio industry.

There are six models available for pre-heating moulding powders ranging in size from 0.2 to 5 KW H.F. output. Each heater is fitted with horizontal platen electrodes between which the powder is heated. Adjustment of the electrode gap is by external control, a neon tube indicator is fitted to show when the electrodes are alive. An automatic timer control is fitted to all models (see also p 310).

Dawe Instruments Ltd. **Stand 201**

This company are exhibiting a wide range of electronic instruments, many of which are of new design. Special stress has been laid on their application to the radio industry both in the laboratory and assembly line. The instruments will include:

(a) Test apparatus for communication work and radio laboratories.

(b) Stroboscopes for speed determination and viewing rotary parts in slow motion.

(c) Flash units for analysis using high speed photography.

(d) Apparatus for the determination of moisture in timber as applied to cabinet making.

A further new instrument is the decade inductometer type 230A. This has a range of 111.1 mH in steps of 10 μH

Electric & Musical Industries Ltd. **Stand 212**

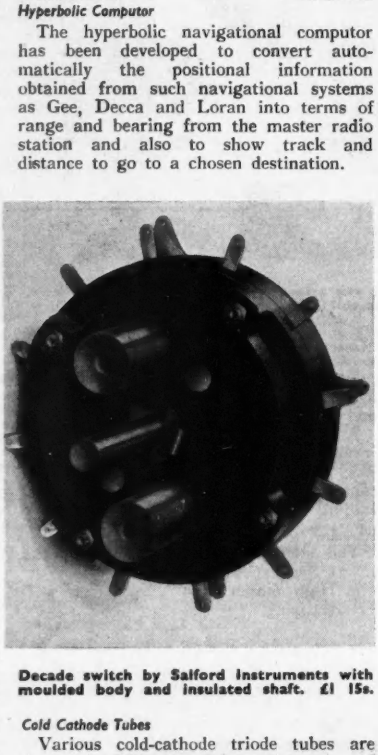
Film Scanner

The television section of the E.M.I. Electronic exhibit includes examples of most recent Emitron camera developments, typical pulse generating equipment, scale model of one of the E.M.I. mobile television vans and an entirely new film scanner. This film scanner is to all intents and purposes foolproof and automatic and provides a very high standard of picture excellence in the transmission of film.

Ferranti Ltd. **Stand 215**

Hyperbolic Computor

The hyperbolic navigational computor has been developed to convert automatically the positional information obtained from such navigational systems as Gee, Decca and Loran into terms of range and bearing from the master radio station and also to show track and distance to go to a chosen destination.



Decade switch by Salford Instruments with moulded body and insulated shaft. £1 15s.

Cold Cathode Tubes

Various cold-cathode triode tubes are shown having extremely stable characteristics such as striking voltage, and capable of operating as relay tubes up to 600 pulses per second where the mean current does not exceed 5 mA (see also p. 309).

"Tesvac" Unit

A portable source of H.F. current for vacuum testing and other applications. The output frequency is approximately 4 Mc/s. and the unit is fitted with a probe in an insulated handle (see page 309). Weight: approximately 9 lb. Dimensions: 6½ in. by 5½ in. by 4½ in.

Edison Swan Electric Co. **Stand 49 & 219**

The Edison Swan Co. are sole distributors to the radio trade of Morganite radio products, and the stand has a selection of potentiometers, resistors, and interference suppressors.

In addition to Mazda miniature valves (see ELECTRONIC ENGINEERING for July, 1947, p. 231) there are cathode ray tubes for television and new B.T.-H. loudspeakers

The electronics section (Stand 219) displays electro-medical equipment including the Ediswan electroencephalograph and low frequency analyser for use in conjunction with it.

The General Electric Co. **Stand 221**

V.H.F. equipment arranged to display systems developed by the G.E.C. and installed in police, fire, ambulance, harbour and similar services.

Magnetic Tape Recorder

The recorder exhibited is the medium fidelity model intended for home recording and reproducing and for use at any functions where long playing time and good quality output are advantageous. Level response from the lowest audio frequencies up to some 5-6,000 c/s. indicates that "medium fidelity" requires appropriate interpretation here.

A plastic tape impregnated with iron oxide is used and facilities are provided for the rapid and complete "wiping out" of the recording, so that the tape may be used again repeatedly if required. Maximum playing time is 35 minutes and other features of this semi-portable unit are simplicity of operation, easy tape loading and concentric mounting of the drums which carry the tape. This latter is a unique feature and results in considerable space saving and general compactness.

Export Receivers

A comprehensive range of export models, built to full tropical specification, forms an important part of the G.E.C. display (see also p. 309).

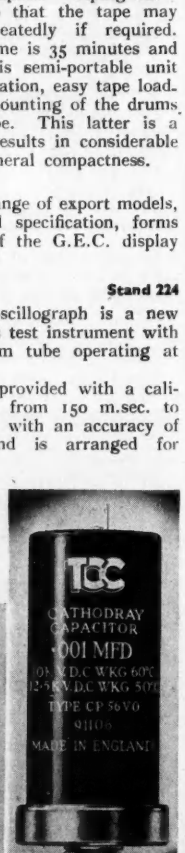
A. C. Cossor, Ltd. **Stand 224**

The model 1035 oscillograph is a new laboratory and works test instrument with a Cossor double-beam tube operating at 2 KV.

The time base is provided with a calibrated scale reading from 150 m.sec. to 15 μsec. in 9 ranges with an accuracy of ± 10 per cent. and is arranged for

Right: **T.C.C. new Cathodray capacitor for H.T. circuits.**

Below: **One of the types of Dubilier precision wire-wound resistors.**



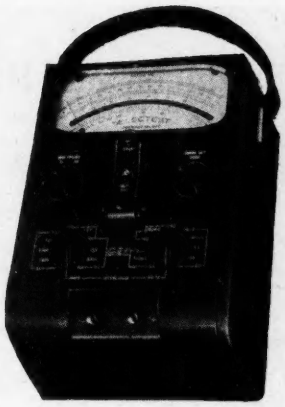
repetitive, single stroke, or triggered operation. The sensitivity of the Y-plates is 3 V/mm. direct, and the Y-axis has internal amplifiers with a maximum gain of 3,000 and a L.F. response down to 20 c/s. The maximum frequency on low gain is 10 Mc/s.

The model 1049 is designed more especially for industrial users and has a frequency response from D.C. to 100 Kc/s. The time scale is also calibrated and ranges from 1.5 sec. to 150 μsec.

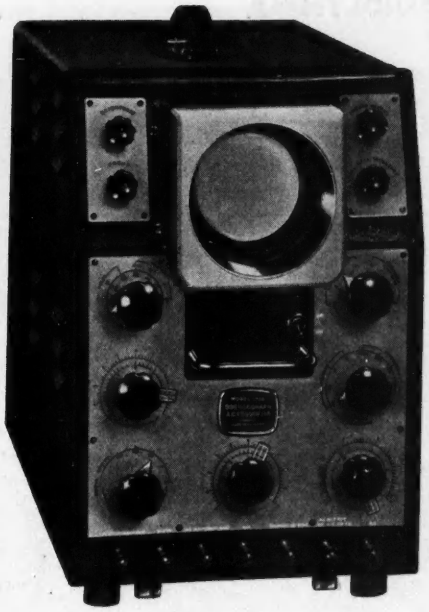
The amplifiers are stabilised against mains variations and long period stability is reached in 5-10 minutes from switching on.

This company is also showing two C.R. tubes: the type 88 supersedes the type 26 and has a flat screen of 90 mm. diameter with a (normal) green colour. Heater volts 6.3, max. anode volts 2 KV. Single beam.

The type 89 is a double-beam tube superseding type 09. This is similar in other respects to the type 88 and the intermodulation between Y-plates is less than 1 per cent.



Above: **G.E.C. "Selectest" multi-range test meter.**



Right: **New Model 1035 double-beam oscillograph by A.C. Cossor.**

Philips Electrical Limited Stand No. 227

High Frequency Generators,

Two types of H.F. generators for the induction heating of metals: Type F12/1 with a maximum power input of 5 KW (demonstrated) and type F.V.100 with a maximum power input of 50 KW. Applications include hardening, soldering, sintering and melting.

Mass X-ray Unit

The Philips "Photalix" mass chest X-ray unit has been designed exclusively for chest work and developed in close collaboration with the medical profession.

Short Wave Therapy

The "Metalix 300" short wave therapy unit has an output of 300 watts on a wavelength of 6 metres. The heart of any short wave unit is its oscillator valve. Philips has constructed a silica valve especially for this type of apparatus.

Welding Control Unit

Philips electronic welding control unit has been developed to give very accurate control of the energy output of resistance welding machines.

A feature of this unit is the use of normal domestic valves for the purpose of controlling industrial valves.

Standard Telephones & Cables Ltd. Stand 228

The major item in the display is the final R.F. amplifier of a "Standard Radio" type CS8 100/130 KW high frequency broadcasting transmitter. This type of equipment has been supplied in considerable numbers to broadcasting administrations for the high fidelity transmission of programmes to all quarters of the globe. Notable among the features of the CS8 is the provision of separate R.F. channels for each working frequency, permitting rapid change of frequency, and making accessible for maintenance the apparatus for channels not in service.

Specialised techniques of "Standard" are represented by the section of the Stand devoted to quartz crystals. In addition to a display of quartz in its natural, partly processed and finished states there is a demonstration of crystal cutting by automatic machinery; and a number of working exhibits demonstrate the piezo-electric effect, motion of vibration and air currents set up by quartz crystals. Of particular interest is a demonstration of a vibrating crystal transmitting ultrasonic energy through a liquid.

Electrical and Radiological Inst. Co. Stand 231

Single Phase/Two Phase Transformer

This is a new departure in electrical equipment. The transformer has obvious applications in fluorescent lighting and fractional horse power motors. The advantages of a two-phase supply for these applications are well known. The transformers are housed in a completely enclosed steel case and are tapped to cover a voltage range of 200/250 A.C. Sizes of the transformers immediately available are from 20 W to 500 W. (Pat. applied for.)

Also shown are a gramophone motor and turntable complete, the motor energised from the same transformer, and a 2-phase motor in various sizes from 1/10th h.p. to ½ h.p.

Among the components exhibited are tuning coils, I.F. transformers, power transformers, and vibrator units. Several laboratory instruments are also shown.

Metropolitan-Vickers Electrical Company Stand No. 233

The "Seascan" radar, designed to meet the Ministry of Transport's specification for radar for merchant ship service, is claimed to have been the first such set commercially developed and installed in merchant ships. The set has four ranges; it can detect objects up to 30 miles distant and, what is even more remarkable and important, it can give clear indications of objects as near as 50 yards.

A remarkable new development is the production of a really portable cathode-ray oscilloscope measuring only 10½ in. by 5½ in. by 3½ in. Although this instrument falls into the midget class, it is complete in every way and employs a tube with a 2¾ in. screen.

The production of electronically stabilised power units which supply current at a constant pressure irrespective of variations of mains voltage, will satisfy a long-felt want. New Metrovick units are exhibited which can provide current at a pressure constant within 0.01 per cent. over a whole day, or 0.001 per cent. from minute to minute, with mains-voltage variations as great at ± 10 per cent. Two models are on show, both giving a D.C. output; one can deliver 250mA at any pressure up to 650 V, and the other supplies current at pressures up to 400 V.

Gamma Electronics Ltd. Stand 238

The radio exhibit of this company comprises a basic design of domestic receiver which can be supplied in a choice of three cabinet styles and two waveband coverages. All models for export are named "Bryanston" and are sold through Messrs. James Coombs Ltd., London.

A new office intercommunication system has three possible circuit arrangements, including an "all-stations" call in which a reply from one circuit automatically closes the line and transforms the call into a private station-to-station call. Delivery one month.

RADIOLYMPIA

Classified List of Products and Manufacturers

This list, which refers to exhibitors only, is compiled from advance information supplied and is not necessarily complete. For addresses of exhibitors, see Directory on succeeding pages.

Accumulators
Edison Swan Electric Co., Ltd.
General Electric Co.
Varley Dry Accumulators Ltd.

Aerials
Aerialite Ltd.
Antiference Ltd.
Belling & Lee Ltd.
B.I. Callender's Cables Ltd.
New London Electron Works Ltd.
Shannons & Bishop Ltd.

Amplifiers
Birmingham Sound Reproducers Ltd.
Decca Record Co.
Dynatron Radio Ltd.
Grampian Reproducers Ltd.
Lowther Mfg. Co.
McMurdo Instrument Co.
Trix Electrical Co.
Tannoy Ltd.

Battery Chargers
Crypton Ltd.
Davenset (Partridge Wilson Ltd.).
Westinghouse Brake & Signal Co. Ltd.

Cables
Aerialite Ltd.
British Insulated Callender's Cables Ltd.
Standard Telephones & Cables Ltd.
Sterling Cable Co.
Telegraph Construction & Maintenance Co.

Capacitors (Fixed)
B.I. Callender's Cables Ltd.
Dubilier Condenser Co.
†Edison Swan Electric Co., Ltd.
Erie Resistor Ltd.
Franklin Electric Co.
Hunt, A. H. Ltd.
Lee Products
London Electrical Manfg. Co. Ltd.
*Plessey Co. Ltd., The.
Static Condenser Co.
Telegraph Condenser Co.
United Insulator Co.
** Electrolytic* *† Vacuum type*

Capacitors (Variable)
Bird, S. & Sons (Cyldon)
Lee Products
Plessey Co., Ltd.
Stratton & Co.
Wingrove & Rogers, Ltd.

C.R. Oscillographs (—scopes)
Cossor, A. C. Ltd.
Metropolitan-Vickers Electrical Co., Ltd.
Mullard Wireless Service Co.
Taylor Electrical Instruments Ltd.

Cathode Ray Tubes
Cossor, A. C. Ltd.
Edison Swan Electric Co.
Ferranti Ltd.
General Electric Co., Ltd., The
Mullard Wireless Service Co.

Chokes (L.F.)
Bulgin, A. F. & Co.
Haynes Radio Ltd.
R. M. Electric Ltd.
Plessey Co. Ltd., The.

Coils (Tuning)
Bulgin, A. F. Ltd.
Electrical & Radiological Inst. Co. Ltd.
R.M. Electric Ltd.
Stratton & Co., Ltd.
Weymouth Radio Manfg. Co. Ltd.
Wright & Weaire, Ltd.

Components
Bulgin, A. F. & Co.
Farnell, A. C. Ltd.
Franklin Electric Co. Ltd.
Lee Products Ltd.
Qualrad Products Ltd.
Ripaults Ltd.
(See also under individual items)

Components (Small)
Belling & Lee Ltd.
British Mechanical Productions Ltd.
Bulgin, A. F. Ltd.
Stratton & Co., Ltd.
Tucker Eyelet Co.

Crystals
British Centralab Ltd. (R. A. Rothermel Ltd.).
General Electric Co., Ltd.
Marconi's W/T Co.
Salford Electrical Instruments Ltd.

Dials and Drives
Plessey Co. Ltd., The
" Q-Max " Electronics Ltd.
Salford Electrical Instruments Ltd.
Stratton & Co., Ltd.
Wingrove & Rogers Ltd.

Disk Recorders
Birmingham Sound Reproducers Ltd.
E.M.I. Ltd.
Simon Sound Service.
Tannoy, Ltd.

Electromedical Apparatus
Edison Swan Electric Co., Ltd.
Electrical and Radiological Instrument Co.
Marconi Instruments Ltd.

Gramophone Units
Acoustical Manufacturing Co. Ltd.
Birmingham Sound Reproducers Ltd.
Collaro, Ltd.
Electrical & Radiological Inst. Co. Ltd.
Garrard Engineering & Mnfg. Co. Ltd.

Headphones
British Centralab Ltd.
Edison Swan Electric Co. Ltd.

Hearing Aids
Bell, John & Croyden Ltd. (Savory & Moore Ltd.).
Electrical & Radiological Inst. Co. Ltd.
Ossicaide

Insulators
Steatite & Porcelain Products Ltd.
United Insulators Co., Ltd.

Intercom Sets
Edison Swan Electric Co., Ltd.
Electrical & Radiological Inst. Co. Ltd.
Gamma Electronics Ltd.

Iron Dust Cores
Plessey Co. Ltd., The.
Salford Electrical Instruments Ltd.
Standard Telephones & Cables Ltd.
Telegraph Construction & Maintenance Co.

Loudspeakers
*Acoustic Products Ltd.
Acoustical Mfg. Co.
Amplion (1932) Ltd.
British Rola Ltd.
Celestion Ltd.
Edison Swan Electric Co. Ltd.
Electrical & Radiological Inst. Co. Ltd.
Goodman's Industries Ltd.
Lowther Manfg. Co. Ltd. (Voigt).
Page Engineering Co. Ltd.
Plessey Co. Ltd., The.
Raimo Raidio Ltd.
Tannoy Products
Truvox Engineering Co., Ltd.
*Vitavox Ltd.
*Wharfedale Wireless Works
** In cabinets*

Magnets and Magnetic Materials
Mullard Wireless Service Co., Ltd.
Standard Telephones & Cables Ltd.
Scott, G. L. & Co. Ltd.
Telegraph Construction & Maintenance Co., Ltd.

Meters (Indicating)
Automatic Coil Winder & Electrical Equipment
Dawe Instruments Ltd.
Everett, Edgcumbe & Co., Ltd.
Ferranti Ltd.
Salford Instruments Ltd.

Microphones
Acoustical Manfg. Co., Ltd.
Birmingham Sound Reproducers Ltd.
British Centralab Ltd.
E.M.I. Sales & Service Ltd.
Micramatic Electrical Inst. Co. Ltd.
Standard Telephones & Cables Ltd.
Trix Electrical Co., Ltd.

Motors (Gramophone)
Collaro Ltd.
Edison Swan Electric Co., Ltd.

Oscillators (A.F.)
Birmingham Sound Reproducers Ltd.
Dawe Instruments Ltd.
Marconi Instruments Ltd.

Oscillators (R.F.)
Automatic Coil Winder & Electrical Equipment
Dawe Instruments Ltd.
Marconi Instruments Ltd.

(Continued on page 317)

● The remarkable power factor and outstanding electrical insulating properties of "STYRAFOIL" brand Polystyrene have long been recognised by the electrical, radio and television industries. "STYRAFOIL" has a power factor of 0·0002-0·0004 which together with its negligible water absorption, has made possible the manufacture of equipment and apparatus not hitherto considered feasible. Its use in Radar equipment was a notable war-time achievement. Now "STYRAFOIL" is available for developments in expanding peace-time industry.

"STYRAFOIL" (Orientated Polystyrene Foil) is a plastic material endowed, as a result of molecular control during manufacture, with ten times the normal flexibility of ordinary Polystyrene film. It is supplied in spools of approximately 800 ft. lengths, from ⅛" up to 13" in width, and in thicknesses from ½/1000" to 6/000". Even in the thinnest dimensions this foil possesses a tensile strength of up to 10,000 lbs. to the square inch, and has the same superb electrical properties of Polystyrene mouldings and extrusions. A vast number of products and techniques awaits its use. Send for samples and further information.

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Manchester Blackfriars 0258

42 Wellington Street · Sheffield
Sheffield 25517

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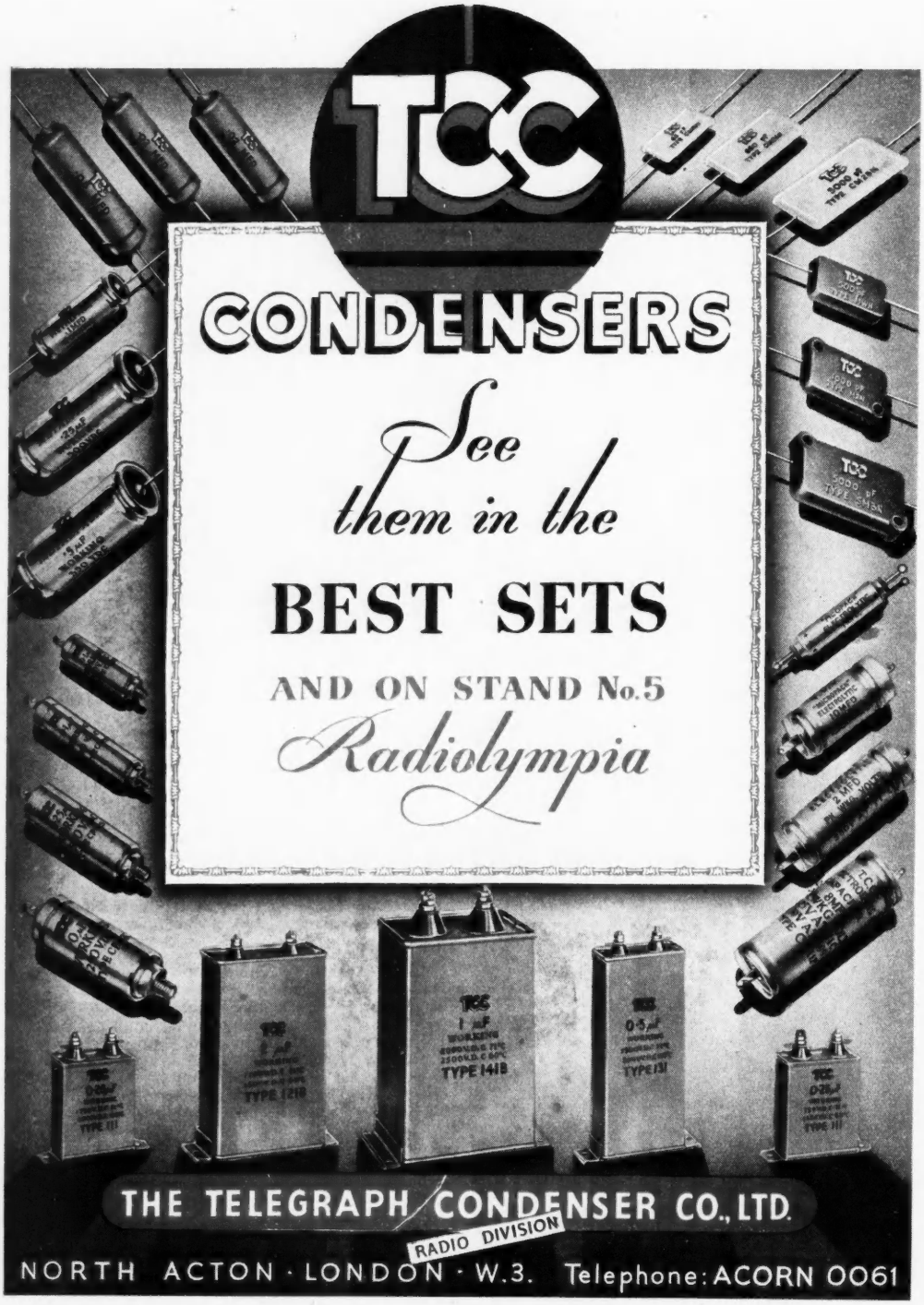
TAYLOR 1400


TCC
CONDENSERS
See
them in the
BEST SETS
AND ON STAND No.5
Radiolympia
THE TELEGRAPH CONDENSER CO., LTD.
RADIO DIVISION
NORTH ACTON · LONDON · W.3. Telephone: ACORN 0061

RADIOLYMPIA

Classified List of Products and Manufacturers—*continued*

P.A. Equipment
Acoustical Manfg. Co. Ltd.
British Vacuum Cleaner & Engg. Co. Ltd.
E.M.I. Sales & Service Ltd.
Grampian Reproducers Ltd.
General Electric Co. Ltd.
Pye Radio Ltd.
R.S.C. Radio Ltd.

Pickups
Amplion (1932) Ltd.
British Centralab Ltd.
Decca Record Co.
Edison Swan Electric Co., Ltd.
Electrical & Radiological Inst. Co. Ltd.
Garrard Engineering & Mfg. Co. Ltd.
Goldring (E. Schaff) Ltd.
Lowther Manufacturing Co. Ltd. (Voigt).
Tannoy, Ltd.
Truvox Engineering Co., Ltd.

Plastic Materials
Barclay Stuart (Plastics) Ltd.
British Moulded Plastics Ltd.
De La Rue Insulation Ltd.
Telegraph Construction & Maintenance Co., Ltd.
Tenaplas Ltd.

Potentiometers
British Centralab Ltd.
Dagole Ltd.
Dubilier Condenser Co. (1925) Ltd.
Franklin Electric Ltd.
Plessey Co., Ltd., The.
Edison Swan Electric Co., Ltd.

Radar Equipment
British Thomson-Houston Co., Ltd., The.
Cossor, A. C. Ltd.
Metropolitan-Vickers Electrical Co., Ltd., The
Marconi Wireless Telegraph Co., Ltd.

Radio Receivers (*including Radiograms*)
Ace Radio Ltd.
Aerodyne Ltd.
Allander Industries Ltd.
Amplion (1932) Ltd.
†Armstrong Wireless & Television Co. Ltd.
Baird, J. L. Ltd. T
Balcombe, A. J. Ltd. (Alba). T
Beethoven Elec. Equipment Co. Ltd. T
British Vacuum Cleaner & Engg. Co. Ltd.
Burndept Ltd. T
Burgoyne Electrical Co. Ltd.
Bush Radio Ltd. T
Cossor, A. C. Ltd. T
Decca Record Co. Ltd.
Dibben, H. Ltd.
Dynaport Radio & Television Ltd.
Dynatron Radio Ltd. T
Electrical & Radiological Inst. Co. Ltd. T
Emor Radio Ltd.
Felgate Radio Ltd. T
Ferguson Radio Ltd. T
Ferranti Ltd. T
Fidelity Radio Ltd.
Fitton, R. N. & Co. Ltd.
General Electric Co. Ltd. T
General Electrical Radio Ltd.
Gramophone Co. Ltd., The. T
Hale Electrical Co. Ltd.
Invicta Radio Ltd. T
Kolster Brandes Ltd. T
Lee Products Ltd.
McMichael Radio Ltd. T
Marconiphone Co. Ltd. T
Masteradio Ltd.
Mullard Wireless Service Co. Ltd.
Murphy Radio Ltd. T
Parker Radio Mfg. Co. Ltd.
Peerless Radio Ltd.
Peto Scott Ltd.
Philco Radio & Television Corpn. Ltd. T
Philips Electrical Ltd. T
Pilot Radio Ltd. T
Portogram Ltd.
Pye Radio Ltd. T
R.M. Electric Ltd.
Radiogramophone Development Co. Ltd. T
R.S.C. Radio Ltd.
Radio Instruments Ltd.
Regentone Products Ltd.
Roberts Radio Ltd.
Romac Radio Ltd.
Sobell Industries Ltd. T
Ultra Electric Ltd. T
V.S.E. Construction Co. Ltd.
† *Chassis.* *T=Television.*

Rectifiers (*Metal*)
Salford Electrical Instruments Ltd.
Standard Telephones & Cables Ltd.
Westinghouse Brake & Signal Co., Ltd.

Resistors
Dagole Ltd.
Franklin Electric Ltd.

Resistors (Fixed)
Erie Resistor Ltd.
Dubilier Condenser Co. (1925) Ltd.

R.F. Heating Equipment
B.I. Callenders Cables Ltd.
British Thomson-Houston Co., Ltd., The.
E.M.I. Ltd.
General Electric Company Ltd.
Metropolitan-Vickers Electrical Co., Ltd.
Murphy Radio Ltd.
Philips Electrical Ltd.
Pye Radio Ltd.

Rotary Converters
Electrodynamic Construction Co. Ltd.
Scott, G. L. Ltd.

Switches
Bulgin, A. F. & Co., Ltd.
Electrothermal Engineering Co.
Wright & Weaire, Ltd.

Television Components
Belling & Lee Ltd.
Bulgin, A.F. Ltd.
Haynes Radio Ltd.
*Long & Hambly Ltd.
Pye Radio Ltd.
* *Tube Masks*

Television (Equipment)
E.M.I. Ltd.
Marconi's Wireless Telegraph Co.
Pye Radio Ltd.

Television Receivers
See adjoining column. A detailed list of television receivers will be published in the next issue.

Test Equipment (Laboratory)
Dawe Instruments
Ferranti Ltd.
Marconi Instruments Ltd.
Salford Electrical Instruments Ltd.

Test Equipment (Portable)
Automatic Coil Winder & Electrical Equipment
Crypton Equipment Co. Ltd.
Electrical Instrument Co. (Hillington) Ltd.
Everett Edgcumbe & Co., Ltd.
Metropolitan-Vickers Electrical Co., Ltd.
Taylor Electrical Instruments Ltd.

Transformers (A.F.)
Plessey Co., Ltd., The.
R.M. Electric Ltd.
Wright & Weaire Ltd.

Transformers (I.F.)
Electrical & Radiological Inst. Co. Ltd.
Plessey Co., Ltd., The.
R.M. Electric Ltd.
Wright & Weaire, Ltd.

Transformers (Mains)
Haynes Radio Ltd.
R.M. Electric Ltd.
Plessey Co., Ltd., The.
Wright & Weaire Ltd.
Weymouth Radio Mfg. Co.

Transformers (Power)
Electrical & Radiological Inst. Co. Ltd.
Lee Products Ltd.
Micramatic Electrical Inst. Co. Ltd.

Transmitting Equipment
Mullard Wireless Service Co., Ltd.
" Q-Max " Electronics Ltd.
Stratton & Co., Ltd.

Valveholders
Belling & Lee Ltd.
Bulgin, A. F. Ltd.
British Mechanical Productions Ltd.
McMurdo Instrument Co.
Plessey Co., Ltd.
Pye Radio Ltd.
Stratton & Co., Ltd.

Valves
British Thomson-Houston Co. Ltd.
British Tungsram Radio Works Ltd.
Cossor, A. C. Ltd.
†Edison Swan Electric Co.
Ferranti Ltd.
†Mullard Wireless Service Co., Ltd.
Marconi-Osram (General Electric Co.)
†Standard Telephones & Cables Ltd.
† *Miniatures*

Vibrators
Electrical & Radiological Inst. Co. Ltd.
Masteradio Ltd.
Plessey Co., Ltd., The.
Wright & Weaire Ltd.

Wire (Insulated)
Concordia Electric Wire & Cable Co., Ltd.
De La Rue Insulation Ltd.
Duratube & Wire Ltd.
New London Electron Works Ltd.
Ripaults Ltd.
Sterling Cable Co., Ltd.
Tenaplas Ltd.

Unclassified
Valve Retainers
Electrothermal Engg. Co. Ltd.

Metal Cabinets and Gramophone Accessories
Imhof, Alfred Ltd.

Solder
Multicore Ltd.

RADIOLYMPIA

Directory of Exhibitors

The Stand Number is placed against the firm's name in each case.

Ace Radio Ltd.
Tower Road, Pound Lane, Willesden, N.W.10 55
Acoustic Products Ltd.
50-58, Britannia Walk, City Road, N.1 ... 111
Acoustical Mfg. Co., Ltd.
Ermine Street, Huntingdon, Hunts. ... 147
Aerialite Ltd.
Castle Works, Stalybridge, Cheshire ... 78
Aerodyne Ltd.
Platina Street, E.C.2 7
Albion Electric Stores.
125, Albion Street, Leeds 107
Allander Industries Ltd.
48, Avenue Street, Bridgeton, Glasgow ... 131
Amplion (1932) Ltd.
230, Tottenham Court Road, W.1 ... 85
Antiference Ltd.
67, Bryanstone Street, W.1 2
Armstrong Wireless & Television Ltd.
Warlters Road, Holloway, N.7 205
Automatic Coil Winder & Electrical Equipment Ltd.
Winder House, Douglas Street, S.W.1 ... 113

Baird, John L., Ltd.
4 Upper Grosvenor Street, W.1 50
Balcombe, A. J., Ltd.
52, Tabernacle Street, E.C.2 28
Barclay Stuart (Plastics) Ltd.
Spencer House, South Place, E.C.2 ... 204
Beethoven Electric Equipment Ltd.
Chase Road, N.W.10 61
Bell & Croyden, J. (Savory & Moore Ltd.)
61, Welbeck Street, W.1 117
Belling & Lee Ltd.
Cambridge Arterial Road, Enfield, Middx. 33
Bennett Power Products Ltd. 122
Bernards (Publishers) Ltd.
The Grampians, Western Gate, W.6 ... 321
Bird, Sydney S. & Sons.
Cambridge Arterial Road, Enfield, Middx. 31
Birmingham Sound Reproducers Ltd.
Claremont Street, Old Hill, Staffs. ... 222
British Centralab Ltd. (R. A. Rothermel Ltd.).
Canterbury Road, Kilburn, N.W.6 74
British Insulated Callenders' Cables Ltd.
Prescot, Lancs. 200
British Mechanical Productions Ltd.
21, Bruton Street, W.1 127
British Moulded Plastics Ltd.
Avenue Works, Walthamstow Avenue, E.4 30
British Rola Ltd.
Ferry Works, Thames Ditton, Surrey ... 135
British Thomson-Houston Co., Ltd.
Rugby 213
British Tungsram Radio Works Ltd.
West Road, Tottenham, N.17 132
British Vacuum Cleaner & Eng. Co., Ltd.
Goblin Works, Leatherhead, Surrey ... 121
British Broadcasting Corporation
Broadcasting House, W.1 ... ... 243 & 244
Brown Bros. Ltd.
Browns Bldgs., Great Eastern Street, E.C.2 101
Bulgin, A. F. & Co., Ltd.
By-Pass Road, Barking, Essex 3
Burgoyne Eng. Co., Ltd.
1 and 3, Robert Street, N.W.1 208
Burndept Ltd.
West Street, Erith, Kent 27
Bush Radio Ltd.
Power Road, Chiswick, W.4 38
Board of Trade.
(Export Promotion Dept.), 35, Old Queen Street, S.W.1 84

Cable & Wireless Ltd.
Electra House, Victoria Embankment, W.C.2 223
Celestion Ltd.
145, London Road, Kingston-on-Thames ... 86
Champion Electric Corporation Ltd.
Champion Works, Seaford, Sussex ... 68
Cole, E. K. Ltd.
Ekco Works, Southend-on-Sea, Essex 46 & 110
Collaro Ltd.
Ripple Works, By-pass Road, Barking, Essex 35
Concordia Electric Wire & Cable Co., Ltd.
Long Eaton, Nr. Nottingham 236
Cossor, A. C. Ltd.
Cossor House, Highbury Grove, N.5. 15 & 224
Coventry Factors Ltd.
Radel House, Leicester Row, Coventry ... 145
Crypton Equipment Ltd.
1, Victoria Street, S.W.1. 237

Dagole & Co., Ltd. (J. L. Goldsman & Co)
5, Torrens Street, City Road, E.C.1. ... 66
Dallas, J. E. & Sons Ltd.
Dallas Building, Clifton Street, E.C.2. ... 137
Dawe Instruments Ltd.
Harlequin Avenue, Great West Road, Brentford, Middx. 201
Decca Record Co., Ltd.
1-3 Brixton Road, S.W.9. 14
De La Rue Insulation Ltd.
Imperial House, 84 Regent Street, W.1. ... 44
Dibben, Horace Ltd.
Upper Banister Street, Southampton ... 105
Dubilier Condenser Co. (1925) Ltd.
Victoria Road, North Acton, W.3. 80
Duratube & Wire Ltd.
Faggs Road, Feltham, Middx. 11
Dynatron Radio Ltd.
Perfecta Works, Ray Lea Road, Maidenhead 6

Eastick, J. J. & Sons Ltd.
12, Errol Street, E.C.1. 115
Econasign Co., Ltd.
92, Victoria Street, S.W.1. 316
Edison Swan Electric Co., Ltd.
155, Charing Cross Road, W.C.2. ... 49 & 219
Electric & Musical Industries Ltd.
Hayes, Middx ... ... 29 & 212
Electrical Instrument Co. (Hillington), Ltd.
Boswell Square, Hillington, Glasgow, S.W.2. 218
Electro Dynamic Construction Co., Ltd.
St. Mary Cray, Kent 311
Electrical & Radiological Instrument Co.
54, Church Road, Acton, W.3. 231
"ELECTRONIC ENGINEERING"
28, Essex Street, Strand, W.C.2. 216
Electronic Manufacturers' Association
Vernon House, Sicilian Avenue, W.C.1. ... 318
Electrothermal Engg. Ltd.
270, Neville Road, E.7. 32
Emor Radio Ltd.
45, Kilburn High Road, N.W. 314
Erie Resistor Ltd.
Carlisle Road, The Hyde, N.W.9. 41
Everett, Edgcumbe & Co., Ltd.
Colindale Works, Hendon, N.W.9 ... 76

Farnell, A. C. Ltd.
15, Park Place, Leeds, 1 203
Felgate Radio Ltd.
6, Studland Street, Hammersmith, W.6 120
Ferguson Radio
105, Judd Street, W.C.1 26
Ferranti Ltd.
Hollinwood, Lancs ... ... 57, 77 & 215
Fidelity Radio
11, Blechynden St., North Kensington, W.11 309
Fitton, R. N. Ltd.
Radio Works, Hutchinson Lane, Brighouse, Yorks. 114
Franklin Electric Co., Ltd.
27a, Howland Street, W.1 143

Gamma Electronics Ltd.
12, Greenford Road, Greenford, Middx. ... 238
Garrard Engg. & Mfg. Co., Ltd.
Newcastle Street, Swindon, Wilts. ... 24
General Electric Co., Ltd.
Magnet House, Kingsway, W.C.2 ... 70 & 221
General Electrical Radio
92, Charlotte Street, W.1 217
General Post Office
London, E.C.1 ... ... 302, 303 & 304
Goodmans Industries Ltd.
Lancelot Road, Wembley, Middx. 87
Gramophone Co., Ltd., (H.M.V.)
Hayes, Middx. 59
Grampian Reproducers Ltd.
Hanworth Trading Estate, Feltham, Middx. 79

Hale Electric Co., Ltd.
Radio Works, Talbot Road, W. Ealing, W.13 67
Haynes Radio Ltd.
Queensway, Enfield, Middx. 53
Hobday Bros. Ltd.
21-27 Great Eastern Street, E.C.2 116
Hunt, A. H. Ltd.
Garratt Lane, Wandsworth, S.W.18 ... 88

Iliffe & Sons Ltd.
Dorset House, Stamford Street, S.E.1 ... 242
Imhof, Alfred Ltd.
112-116 New Oxford Street, W.C.1 ... 62
Invicta Radio Ltd.
Parkhurst Road, N.7 69

Keith Prowse & Co., Ltd.
159, New Bond Street, W.1 89
Kerry's (Gt. Britain) Ltd.
Warton Road, Stratford, E.15 140
Kleergaze
30a Sackville Street, W.1 317
Kolster-Brandes Ltd.
Footscray, Sidcup, Kent 48

Lee Products (Gt. Britain Ltd.)
Radio House, East Street, Brighton ... 207
L.E.S. Distributors Ltd.
15, Alfred Place, W.C.1 148
London Electrical Mfg. Co., Ltd.
459 Fulham Road, S.W.10 ... ... 9 & 10
London & Provincial Factors Ltd.
236, Tottenham Court Road, W.1 ... 123
Long & Hambly Ltd.
Empire Works, Slater Street, High Wycombe, Bucks. 146
Lowther Mfg. Co. (Lowther - Voigt)
Lowther House, St. Mark's Road, Bromley, Kent 323
Lugton & Co., Ltd.
209 Tottenham Court Road, W.1 ... 141

McMichael Radio Ltd.
190, Strand, W.C.2 60
McMurdo Instrument Co., Ltd.
Victoria Works, Ashtead, Surrey ... 42
Marconi Instruments Ltd.
St. Albans, Herts 226
Marconiphone Co., Ltd.
Hayes, Middx. 37
Marconi's Wireless Telegraph Co., Ltd.
Marconi House, Chelmsford, Essex ... 225
Masteradio Ltd.
319, Euston Road 130
Metropolitan Police
New Scotland Yard, S.W.1 211
Metropolitan Vickers Electrical Co., Ltd.
Trafford Park, Manchester 17 233
Micramatic Electrical Instrument Co., Ltd.
Meico Works, Congleton, Cheshire ... 21
Morgan Bros. (Publishers)
28, Essex Street, Strand, W.C.2 216
Mullard Wireless Service Co., Ltd.
Shaftesbury Ave., W.C.2 ... 71, 112 & 214
Multicore Solders Ltd.
Mellier House, Albemarle Street, W.1 ... 23
Murphy Radio Ltd.
Welwyn Garden City, Herts. ... 72 & 220
Music Trades Review
36, Worship Street, E.C.2 108

New London Electron Works Ltd.
Boleyn Road, East Ham, E.6 22
Newnes, George Ltd.
Tower House, Southampton Street, W.C.2 239

Odhams Press Ltd.
67, Long Acre, W.C.2 106
Ossicaide
Ruvigny Gardens, Putney, S.W.15 ... 232

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Page Engineering Co., Ltd.
Franklin Road, Portslade-by-Sea, Sussex ... 63
Parker Radio Mfg. Co.
756, Harrow Road, N.W.10 315
Partridge Wilson & Co., Ltd.
Davenset Works, Evington Valley Road, Leicester 206
Peerless Radio Ltd.
374, Kensington High Street, W.8 ... 307
Peto Scott Electrical Inst. Ltd.
Addlestone Road, Weybridge, Surrey ... 8
Petter Radio & Electrical Supplies
201, Forest Road, Walthamstow, E.17 ... 102
Philco Radio & Television Corporation of G.B. Ltd.
204, Great Portland Street, W.1 25
Philips Electrical Ltd.
Century House, Shaftesbury Ave. W.C.2 16 & 227
Pilot Radio Ltd.
31-37 Park Royal Road, N.W.10 39
Plessey Co. Ltd.
Vicarage Lane, Ilford, Essex... 65
Portadyne Radio
18-19 Gorst Road, N. Acton, N.W.10 ... 12
Portogram Radio Electrical Industries Ltd.
Preil Works, St. Rule Street, S.W.8 ... 56
Puckridge, F. & Nephew Ltd. ... ...
Mount Works, 96 Upper Clapton Road, E.5 308
Pye Ltd.
Radio Works, Cambridge ... 58 & 229

"Q-Max" (Electronics) Ltd.
10, Little Turnstile, W.C.1 234
Qualrad Products Ltd.
29, Red Lion Street, Richmond, Surrey ... 241

R.M. Electric Ltd.
Team Valley, Gateshead, 11 51
R.S.C. Radio Ltd.
40, Welbeck Street, W.1 45
Radio Gramophone Development Co., Ltd.
Pale Meadow Works, Bridgnorth, Shropshire 36
Radio Instruments Ltd.
Purley Way, Croydon, Surrey 52
Raimo Raidio Products
18, Old Torquay Road, Paignton, Devon ... 305
Radio & Television Retailers Association
18 Woburn Square, W.C.1 100
Radiomobile Ltd.
Cricklewood Works, Cricklewood, N.W.2 144
Radiospares Ltd.
19-23 Fitzroy Street, W.1 73
Regentone Products Ltd.
Eastern Ave., Romford, Essex 40
Relay Services Association of Gt. Britain
25, High Street, Tunbridge Wells, Kent ... 320
Ripaults Ltd.
Southbury Road, Enfield, Middx. 1
Roberts Radio Co., Ltd. ...
Creek Road, East Molesey, Surrey... ... 43
Romac Radio
The Hyde, Hendon, N.W.9 129
Radio Wholesalers Federation
56, Gordon Square, W.C.1 103

Salford Electrical Inst. Ltd.
Peel Works, Silk Street, Salford, Lancs. ... 75
Scharf, Erwin
49, De Beauvoir Road, N.1 306
Scott, Geo. L. & Co., Ltd.
Cromwell Road, Ellesmere Port, Cheshire 109
Shannons & Bishop Ltd.
182, Wardour Street, W.1 104
Simon Sound Service
48, George Street, Portman Square, W.1 ... 209
Sinclair's Publications Ltd.
13, St. George Street, Hanover Sq. W.1 ... 124
Sless, Ben (Tools) Ltd.
Park Cross Street, Leeds, 1... 322
Sobell Industries Ltd.
Langley Park, Nr. Slough, Bucks 19
Standard Telephones & Cables Ltd.
Connaught House, Aldwych, W.C.2 47, 64 & 228
Static Condenser Co., Ltd.
Wokingham, Berks. 210
Steatite & Porcelain Products Ltd.
Stourport-on-Severn, Worcs. 18
Sterling Cable Co., Ltd.
25, Queensway, Enfield, Middx. 128
Stratton & Co., Ltd.
Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31 230

Tannoy Products (Guy R. Fountain) Ltd.
Canterbury Grove, West Norwood, S.E.27 17
Taylor Electrical Insts. Ltd.
419, Montrose Avenue, Slough, Bucks. ... 119
Telegraph Condenser Co., Ltd.
Wales Farm Road, North Acton, W.3 ... 5
Telegraph Construction & Maintenance Co., Ltd.
22, Old Broad Street, E.C.2 118
Tenaplas Ltd.
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Trader Publishing Co., Ltd.
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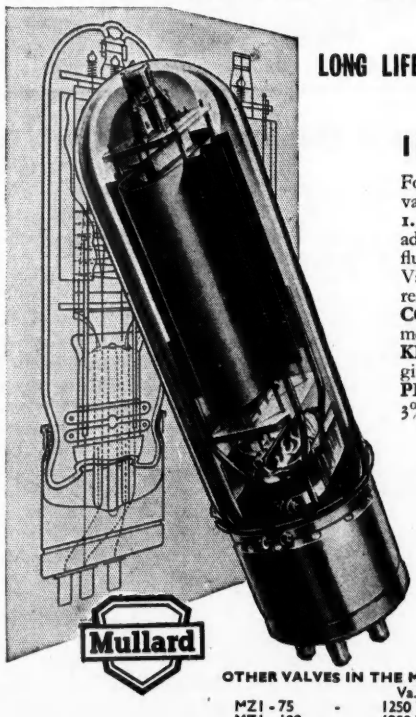
Trix Electrical Co., Ltd.
1-5 Maple Place, Tottenham Court Road, W.1 20
Truvox Engineering Co., Ltd.
Truvox House, Exhibition Grounds, Wembley, Middx. 81
Tucker, Geo. Eyelet Co., Ltd.
Walsall Road, Birmingham, 22 134

Ultra Electric Ltd.
62, Buckingham Gate, S.W.1 13
United Insulator Co., Ltd.
Oakcroft Road, Tolworth, Surbiton, Surrey 126

V.S.E. Construction Co., Ltd.
6, Denman Street, W.1 4
Varley Dry Accumulators Ltd.
By-pass Road, Barking, Essex 202
Vitavox Ltd.
Westmoreland Road, N.W.9 54

Webber, J. M. & Co..., Ltd.
244, Tottenham Court Road, W.1 ... 149
Westinghouse Brake & Signal Co., Ltd.
82, York Way, King's Cross, N.1 ... 34
Weymouth Radio Manufacturing Co., Ltd.
Crescent Street, Weymouth, Dorset ... 142
Wharfedale Wireless Works
Bradford Road, Idle, Bradford, Yorks ... 150
Wingrove & Rogers Ltd.
Mill Lane, Old Swan, Liverpool, 13 ... 139
Winter Trading Co., Ltd.
6, Harrow Road, Paddington, W.2 ... 138
Wright & Weaire Ltd.
2, Lord North Street, S.W.1 125



LONG LIFE WITH *CONSTANT* PERFORMANCE

IN THIS REDESIGNED OUTPUT TRIODE

For amplifiers in the 500-1000 W. range, the new MZ2-200 is an unusually good valve. Here are some of its outstanding advantages:
1. **LONG LIFE FILAMENT.** The filament is oxide coated—a very definite advance in a valve of this size. It will outlast others and is unaffected by normal fluctuations in the mains supply. 2. **CONSISTENT CHARACTERISTICS.** Variation between the characteristics of one MZ2-200 and another is negligible—a real trouble saver in maintenance. 3. **STANDARD DIMENSIONS AND CONNECTIONS.** The MZ2-200 can be used with equal benefit for new equipment or as a straight replacement of equivalent types. 4. **LOW COST PER KILOWATT/HOUR.** Low initial cost, long life and modest filament consumption give an exceptionally low cost per kilowatt/hour. 5. **ELECTRICAL PERFORMANCE.** With two valves in push-pull, 1100W output at less than 3% distortion (see data panel).

MZ2-200 OUTPUT TRIODE

Filament Voltage	14·0 V.	*Mutual Conductance	7·2 mA/V.
Filament Current	2·2 A.	*Amplification Factor	15
Anode Dissipation	275 W.	*Internal Impedance	2085 ohms.

*Measured at Va=2000 V; Ia=180 mA.

TYPICAL OPERATION FOR TWO VALVES IN CLASS AB2 PUSH-PULL

Anode Voltage	2400 V.	Anode Load (anode-anode)	8000 ohms.
Anode Current (no signal)	2×60 mA.	Output Power	1130 W.
Anode Current (max. signal)	2×350 mA.	Total Distortion	2·8%

OTHER VALVES IN THE MULLARD L.F. RANGE

	Va.	wa.
MZ1-75	1250 V.	75 W.
MZ1-100	1250 V.	100 W.

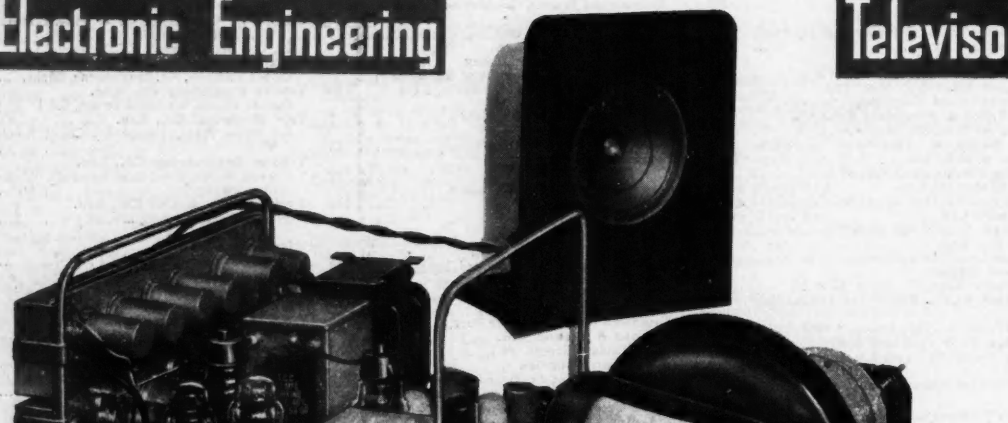
Mullard
THE MASTER VALVE

THE MULLARD WIRELESS SERVICE CO. LTD., TRANSMITTING & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2
MVT 18A

THE

Electronic Engineering

Televisor



A Modern High-Quality Television Receiver for the Home Constructor

Designed by W. I. Flach and N. H. Bentley*

This receiver is being exhibited on the Electronic Engineering Stand No. 216 in the National Hall at Radiolympia. Full details for its construction are available in complete form immediately—see next page.

IN designing a television receiver, the important features of good definition and accuracy of interlacing must be added to the usual ones of stability and freedom from breakdown.

Experience of pre- and post-war television receivers has shown that breakdowns can be avoided by paying particular attention to a few vital components, and in the present design these have been selected to give the utmost reliability.

The definition of the present B.B.C. picture is based on a flat frequency response characteristic up to 2.7 Mc/s. Very few commercial receivers have a response of this range, and the designers considered it essential that the receiver should resolve the 2.5 Mc/s. test lines in the B.B.C. tuning signal. The response of the final design is such that the 3.0 Mc/s. lines are distinguishable when the receiver is correctly adjusted (*see* characteristic curve on adjoining page).

Another important feature is correct interlacing, which has a marked effect on the quality of the picture, and particular care has been taken in the design of the synchronising circuit to give reliable interlacing without critical adjustment.

The work entailed in the construction of the receiver can be undertaken with confidence by the radio experimenter who has had some experience in receiver construction. The most complex units—the vision and sound chassis—have been laid out in a manner which makes for ease in assembly and wiring. Those sections of the receiver which call for careful wiring and screening have been described in greater detail in the book than the sections in which the assembly follows standard amplifier practice.

To provide the utmost flexibility, both the cathode-ray tube and the loudspeaker have been mounted separately from the chassis, and connected to it by flexible leads. This leaves the constructor a wide choice of cabinet construction. Flexible leads up to 6 ft. long can be used to connect the tube to the receiver without deterioration in picture quality.

* The Telegraph Condenser Co., Ltd.

The vision and sound chassis are independent, so that constructors who already possess short-wave receivers for sound may omit the sound portion of this receiver.

Finally, the components have been specified accurately and are all obtainable at the present time.

If the receiver is constructed to the specification given it can be relied on to give first-class results. As is customary, however, the designers and publishers of the circuit must disclaim any responsibility for its performance, although every care is taken in checking the accuracy of the information given.

Circuit

The vision receiver is a four-stage straight R.F. amplifier using Mullard EF. 50 valves, with an overall bandwidth of 4.5 Mc/s.

A single video amplifying stage following the diode rectifier is capable of giving a voltage of 25-30 V peak-peak with an input voltage of less than 100 μV to the receiver.

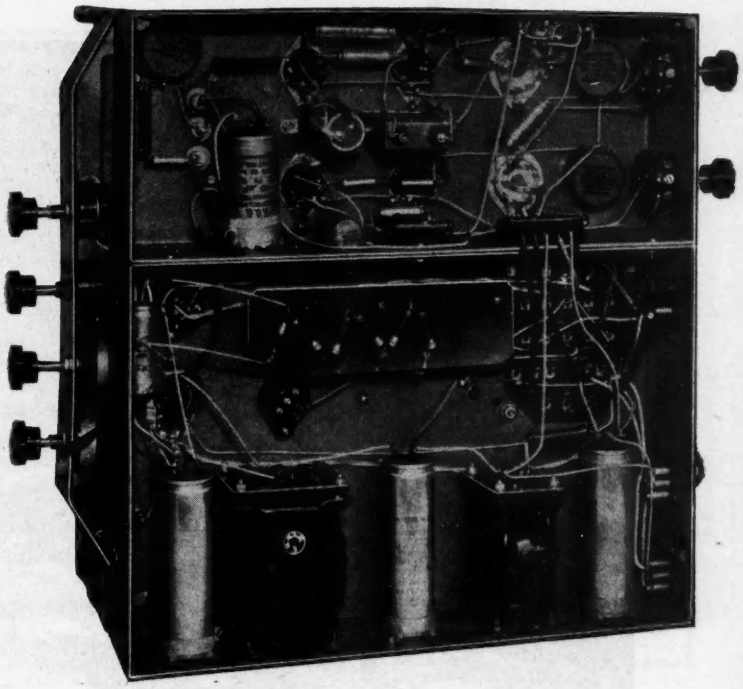
The sound receiver is built on similar lines to the vision receiver and has two R.F. stages followed by a double-diode-triode for rectification, A.V.C. and L.F. amplification.

The tube shown in the illustration is a Mazda CRM. 92 with a 9 in. diameter screen, but a Mullard MW. 22-7 or a G.E.C. 6501 will be equally suitable. The scanning circuit has ample capacity to cover a 12 in. screen.

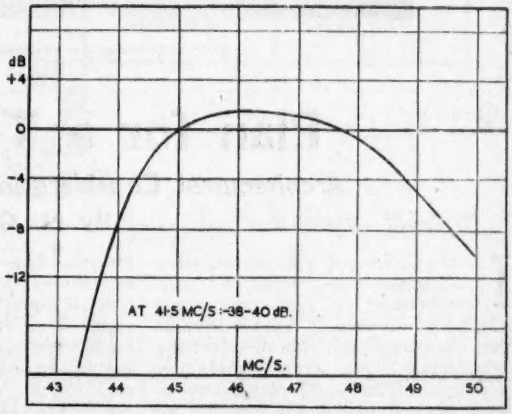
Construction

Arrangements have been made with Messrs. Webbs Radio, of Soho Street, W.1, and Messrs. Tele-radio, Ltd., of 177 Edgware Road, W., to hold a stock of the required components, a list of which is given in full in the booklet: "A Modern Home-built Televisor."

Copies of this booklet are obtainable through the usual suppliers, from the Electronic Engineering Stand at Radiolympia (No. 216, National Hall) or from 28 Essex St., Strand, W.C.2. Price 2s. 6d. (2s. 8d. post free).

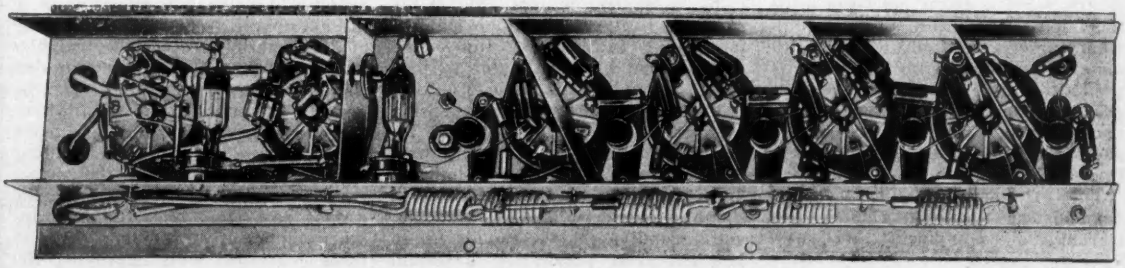


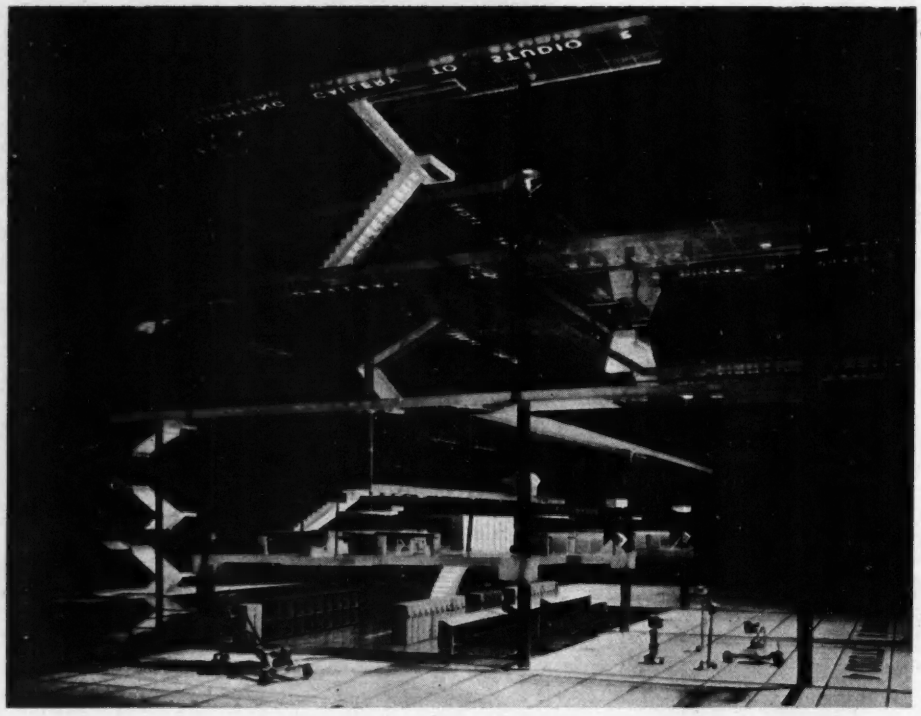
Above: **View of underside of complete receiver, showing power unit, time base circuits and sound output stage. The separate chassis are bolted together as shown.**



Centre: **Frequency response characteristic of vision receiver.**

Below: **View of underside of vision chassis showing the remarkably compact arrangement of components and simplicity of wiring and assembly. The completed chassis will be seen on the left of the receiver shown on the opposite page.**





Model of Television Station showing studio floor, staircases and galleries (Fig. 5)

Plan for a Television Station

Architectural Considerations in Television Station Design

By N. Q. LAWRENCE*

IN the course of a comprehensive programme of research and development on television transmitting equipment, it became obvious that the operational side of television programme production presented problems of an equal complexity to those encountered in the engineering design of the equipment. Although at first sight it might not seem to be the immediate concern of the equipment engineer to study what is ultimately the business of the artistic producer, close attention to these problems showed that, down to the very smallest detail, the technical and operational factors are completely inter-dependent.

The extremely exacting technical demands of television camera and transmitting equipment are well known. The operational demands of a complex television studio production are equally exacting in their own right. The viewer expects to see on his screen images and scenes following on one another in smooth dramatic continuity. A film producer can render such effects by hours of patient labour in studio and cutting-room. If his equipment is unreliable, if his studio is badly laid out, he may be faced with exasperation and added expense, but he is still able to produce a completely satisfactory film.

The artistic success of a television production, on the other hand, requires—assuming a producer with imagination and a sense of timing—firstly, that the technical equipment should function without a breakdown, and secondly, that it should be so laid out as to permit the maximum degree of speed and flexibility in operation.

Further examination of the problem shows that, from the producer's point of view, the term "equipment" does not signify technical apparatus alone. The actors, scenery, lighting, sound effects, etc., etc., all go to make up the medium in which the producer exercises his creative efforts—and if his efforts are to be successful, this medium must be responsive, flexible, and free from any serious points of entanglement. The producer may be equally thwarted in his efforts because a smoothing condenser breaks down, because a badly-sited building stanchion is in the way of the correct camera angle, or because an actor cannot pass from one studio to another sufficiently rapidly; and to those concerned with improving the

* *Pye Ltd., Cambridge.*

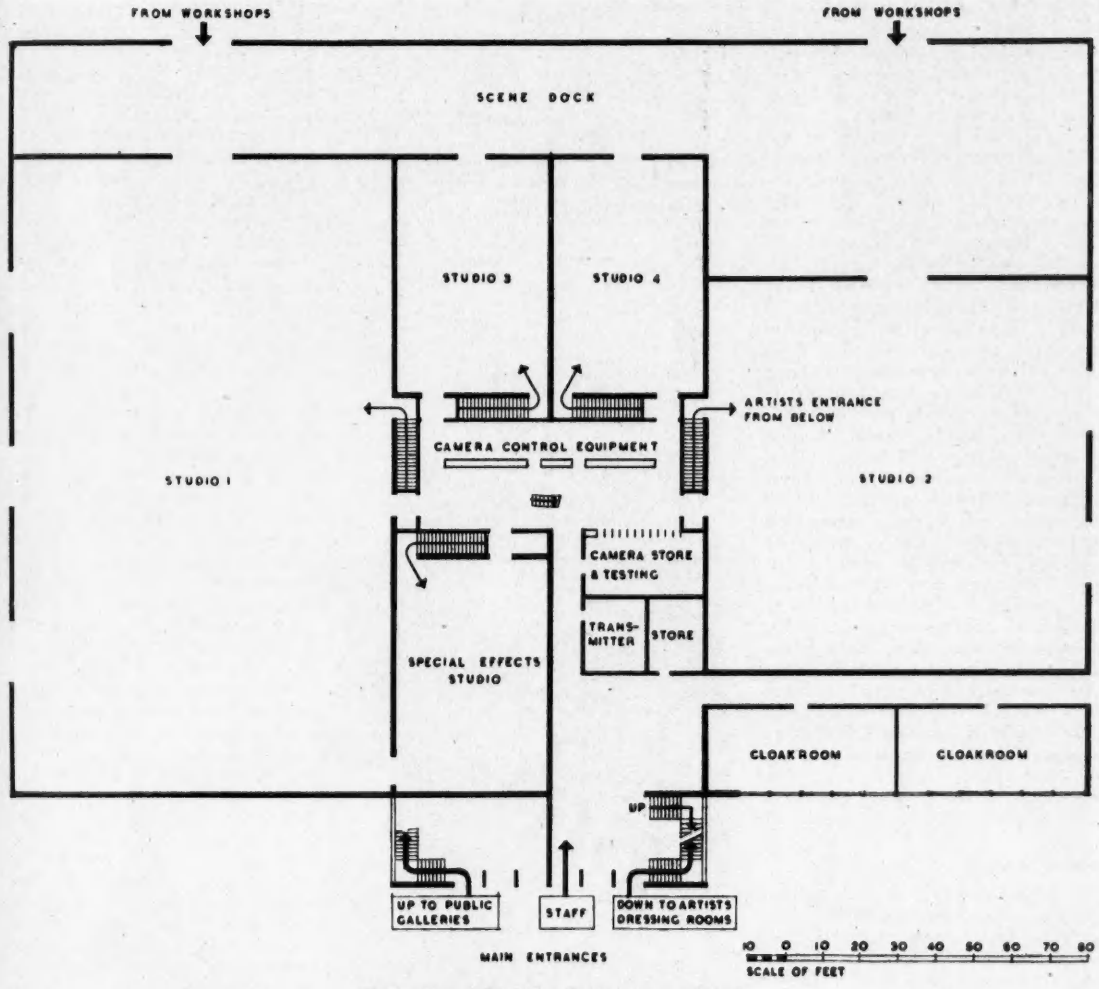


Fig. 1. Plan of Television Station at ground level.

art of television it is short-sighted merely to concentrate on the design of trouble-free apparatus without thought to the final embodiment of the equipment as a whole.

The collaboration between architect and engineer in the study of these problems has resulted in the construction of a formalised model of a television station which is shown in the photograph and in the accompanying figures.

The principles underlying the design are:

(1) Centralisation of technical equipment and control facilities.

(2) Separation from one another of the three categories of personnel using the building, these being: (a) Performers. (b) Technical Operators and Staff. (c) Public.

(3) Adequate circulation for these three categories without mutual interference.

(4) Careful consideration of the number and variety of studios in the station—the number selected being the maximum consistent with adequate centralised control; and the variety of size and shape taking into account all types of performance.

(5) A system of overall design so arranged that the full capacity can be built up in successive stages; the basic central equipment and facilities being laid down in the first instance, and additional studios with their necessary auxiliaries being provided at a later date as required.

Reference to Fig. 1 will show the general ground plan adopted. Referring to section (5) above, the "building sequence" would be in the order: "special effects" studio plus central control; studios 4 and 3; studio 2; studio 1—the last studio being a room of very large size, approximately 100 ft. by 200 ft. by 50 ft. high, for productions of the "super-spectacle" type.

The control facilities are concentrated in a central tower, round which are grouped the five studios. On the ground floor of this tower are the equipment racks serving all cameras in the station. Pictures from these

cameras are continuously viewed here, and all setting-up controls and picture quality adjustments are performed by manipulators who are in communication with the studio control galleries above them.

On the floor above these racks are grouped the five studio control rooms, each identical, looking out into the five studios (*see* Fig. 2). The producer sits forward and at the centre of the room; his position is so arranged that he has a virtually unrestricted view over the entire studio. Attached to the glass partition in front of him are two groups of cathode-ray tube monitors. The first, slightly above his eye level, contains a number of tubes corresponding to the number of picture sources available in the particular studio. A typical arrangement would be a total of six: four cameras on the studio floor, plus two additional sources, such as film, special effects, etc. Below his eye level are two tubes on which he can view the picture selected for transmission and any other selected for "preview." Behind him sits the vision mixing engineer, who, seated on a raised dais, has a clear view of the picture sources in front of the producer. The sound engineer sits to one side of the producer, and ample space is provided for other operators and assistants. Fig. 3 shows the relative positions of producer and vision mixing engineer, and indicates the field of view enjoyed by each.

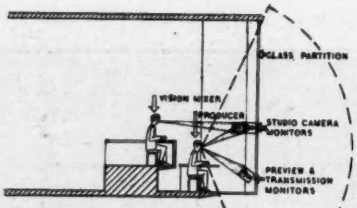


Fig. 2. Section through Studio Control Room.

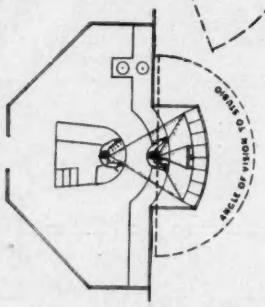


Fig. 3. Plan of Studio Control Room showing Sight Lines.

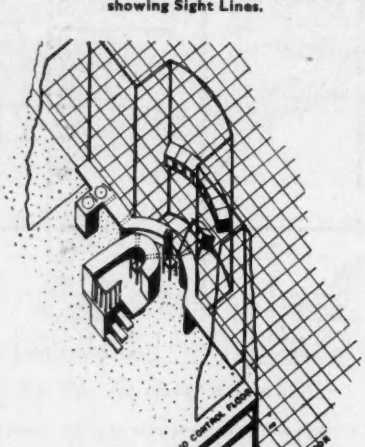


Fig. 4. General View of a Typical Studio Control Room.

Control Master

It will be seen in Fig. 1 that these galleries are grouped together, looking out from the sides of the central tower into their respective studios from a common floor level. Raised up from this floor is a bridge, which extends over the full length of the floor, and which overlooks all five galleries. At the centre of this bridge is the master control console which accepts the outputs from the studios; the station engineer selects these outputs for final transmission. His position is such that he can command from his seat a partial view of all studios, and by moving along the bridge can cover all galleries and studios completely.

The master pulse generator equipment is situated beneath this bridge, being thus approximately equidistant from all camera control racks and picture monitors. It is directly accessible from the equipment room below through a special staircase.

The floor above this control gallery level is devoted to a large public foyer. Windows on three sides of it look into four of the five studios—the fifth studio being designed for special effects work, process and matte shots, etc., as opposed to live performance, a public viewing gallery is not necessary.

Access to these public galleries is through a stairway or lift completely separate from the remainder of the building.

Above the public gallery is the main lighting floor—a central equipment store leading off into galleries which surround the five studios. The two large studios being of greater height than the remainder of the building, subsidiary galleries at roof level are provided, accessible from the main lighting level. This floor also houses auxiliary technical equipment such as telecine, outside broadcast reception, etc. Access from ground level is through the same stair-well as that serving the main technical control, and separate from the public stairway. A bridge from this floor communicates with the upper part of the scene dock; this latter being a large store-room running the full length of the end wall of the building, and having large doors opening through this wall into the four main studios.

The facilities provided for performers are concentrated underground. On entering the building, the artists descend a staircase into a large central foyer beneath the central control tower. Dressing-rooms, make-up rooms, etc., etc., open off this, and separate staircases from a raised mezzanine round the edge of the foyer run up into each studio, giving an entirely separate entry to each studio from that employed by technicians, operators, etc., and at the same time reducing the up-and-down distance covered in going from one studio to another.

A four-storey wing runs out from the main entrance block above the dressing-room wing, containing separate canteens, lavatories, etc., for studio staff and public. These are easily accessible from the main central region; being arranged above one another, an economy is achieved in the centralisation of drainage, water services, etc., while at the same time the necessary separation is maintained.

Fig. 5 shows an impression of the view from studio floor level. It is assumed that the station would be connected by cable or U.H.F. radio link to a high power transmitter on a convenient site.

In conclusion, the author would like to express his indebtedness to Mr. J. M. Grice, of Messrs. Architects' Co-operative Partnership, for his collaboration on the architectural side of the problem; to numerous colleagues in the Television Research Laboratory of Messrs. Pye, Limited, for suggestions and advice; and to the directors of Messrs. Pye, Limited, for permission to publish this article.

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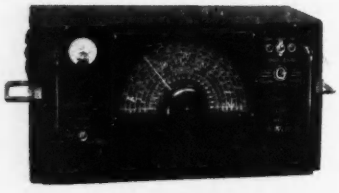

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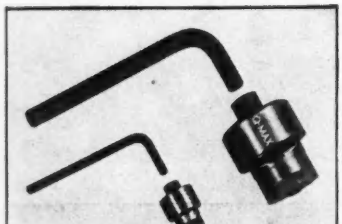

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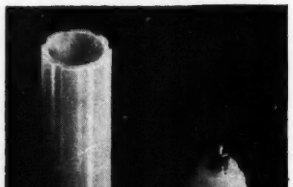

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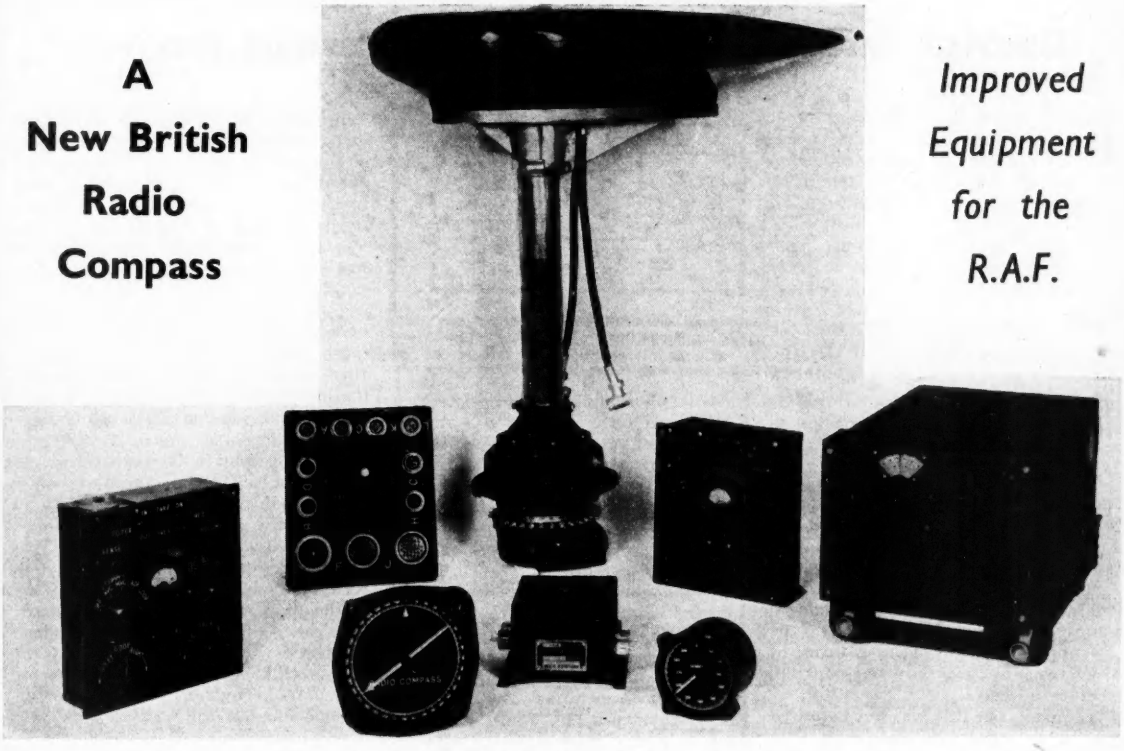


The radio compass and accessories. The pilot's control box is on the left and the main receiver on the right. In front are the navigator's and pilot's indicators and the cathode follower coupling unit.

THE Royal Air Force is to have a new Radio Compass. The advanced instrument of this type yet produced, it was shown for the first time at the R.A.F. Radlett Display and Exhibition and is also on view at the G.E.C. Stand No. 221 at Radiolympia.

The fact that this new Radio Compass is already going into production will undoubtedly be pleasing news for past and present aircrews who were only familiar until now with an American instrument. Since it is understood that the Radio Compass will also be made available for civil aviation purposes, the news will, in fact, be of much wider interest.

In essence, a radio compass is a specialised receiver with specialised aerials, designed so that the signals received from a radio beacon, or other station, give a direct dial reading of the compass bearing of that station. Such bearings are used for navigational purposes in the ordinary way, or for direct homing to the site of the beacon itself.

The radio compass which has been developed to meet the specification of the R.A.F. by the G.E.C., working in collaboration with the Royal Aircraft Establishment, Farnborough, embodies the "Desynn" servo system, and takes advantage of the knowledge which the R.A.F. has gained by experience during recent years. Thus, all remote controls are electrical so that no limit is imposed upon the distance between the various units, while the elimination of mechanical backlash reduces possible error.

The loop aerial, so familiar in its torpedo-shaped housing placed above the fuselage, takes on a very different compact and flattened form, only a few inches in depth. For retrospective fitting to aircraft it is now housed in a shallow "blister" whose air resistance is one-third that of the old standard loop. For incorporation in new machines, the loop is sunk into the aircraft body itself, with a cover moulded to the curvature of the fuselage, so that there is no projection at all.

In the operation of this type of equipment it is necessary to rotate the loop aerial to the position where minimum signal is received from the beacon. With the new radio compass it is only necessary to tune in the beacon and the rest follows automatically—the loop takes up its correct position and the indicators for both pilot and navigator give their readings of the bearing.

If, for some reason, this automatic operation is not required, the loop may be driven round under manual control, and the operator may determine the minimum signal position aurally. Both for tuning and for driving the loop, the operator has only to turn a small knob. If he turns it far, operation is rapid. If he slacks it back, movement is gradual, and if he turns it the other way, all movements are reversed. The whole operation is thus completed in a matter of seconds.

There are other aspects of equal interest—the general presentation, for instance, and, particularly, the accuracy of the whole instrument, which is of the order of one degree or less—an exceptional achievement on the part of the engineers concerned with the conception and development of this new British navigational aid.

Electrical Interference Suppression in Television Receivers

By W. I. FLACH*

IT is increasingly evident that ignition and other short pulse interference is a severe handicap to the full enjoyment of television programmes, particularly in areas of low field strength.

This fact was brought home most forcibly to the writer, when recently carrying out certain tests on a receiver situated close to a main road.

The interference on sound was the most objectionable, as frequently the transmission was completely blotted out, while on vision some 50 per cent. of the picture was obliterated.

It was decided therefore to fit some form of interference suppression on both the sound and vision receivers and in the process to try out various systems to find that which gave the most effective results with the least distortion and minimum adjustment.

Starting with the sound receiver, several methods were considered among them being the Dickert type of suppressor, a modified form of which was fitted in pre-war Murphy receivers (*Jour. Tel. Soc.* Vol. 3, p. 74, 1939), but this was not favoured due to its effect on the high note response. Instead, the first method tried was a simple limiter consisting of a biased diode connected across the detector load resistance and arranged to conduct at amplitudes greater than that equivalent to 100% modulation. (Fig. 1).

The improvement which resulted was not considered sufficiently worth while as only the loudest interference signals were reduced in volume, while at lower audio levels there was no change and interference was received at the same level as the wanted signal.

A modification of this system was to arrange for the diode rectifier to be directly coupled to a pentode amplifier whose grid swing was adjusted so that at inputs equivalent to modulation of over 100 per cent. the valve was driven beyond anode current cut-off, the effect being to suppress interference whose level was greater than the maximum signal. (Fig. 2).

But again interference was apparent at levels below 100 per cent. modulation.

An entirely different approach to the problem was now tried, based essentially on a pulse technique, the object being to discriminate between short period pulses and the wanted signal and to suppress those pulses whose amplitude was greater at any moment than that of the rectified audio signal.

For a system of this type to function satisfactorily, two features are essential in the receiver, these being a wide bandwidth up to the limiter and a narrow bandwidth following the limiter.

The reasons for this will be readily apparent when the nature of ignition type interference is understood.

Fig. 1. Diode limiter across the detector load resistance.

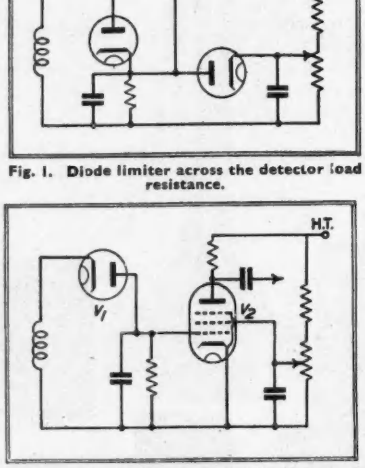


Fig. 2. Detector arranged to drive V_2 beyond anode current cut-off on signals above 100 per cent. modulation.

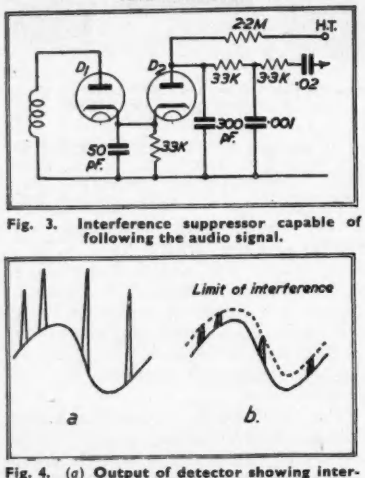


Fig. 3. Interference suppressor capable of following the audio signal.

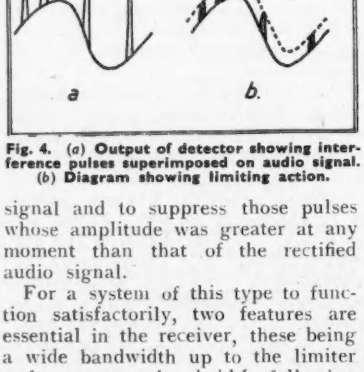


Fig. 4. (*a*) Output of detector showing interference pulses superimposed on audio signal. (*b*) Diagram showing limiting action.

Ignition interference consists of short duration pulses, average periods being of the order of ½ to 20 μS. It will be apparent then, that if a receiver were to be constructed so as not to distort the waveform of the pulses in any way they should not be heard in the loudspeaker since no speaker can respond to such a short pulse.

Unfortunately, from the detector onward receiver circuits integrate these pulses, with the consequence that when the signal has reached the loud speaker it is no longer a steep narrow pulse but a shorter and very much wider one.

To discriminate between an interference pulse and an audio signal it is essential therefore that the waveform of the interfering pulse should be retained up to the limiter. To this effect, the R.F. circuits must have a wide bandwidth and the time constant of the diode rectifier should be small. Typical values found in modern receivers would be a bandwidth of 80 – 100 Kc/s. preceding the detector and a time constant of 1.6×10^{-6} in the detector circuit.

A limiter can now be designed to closely follow the rectified output from the detector and to suppress short pulses of greater amplitude.

The circuit of Fig. 3 is of an interference limiter of this type. The first diode D_1, is the detector, the output being taken from the cathode which is also connected to the cathode of D_2. The diode D_2 is arranged to conduct, the anode being positive with respect to cathode, and there is also a 300 μF capacitor between anode and earth.

On the arrival of a signal at the anode of D_1, rectification takes place and the cathode becomes more positive. The cathode of D_2 will also become more positive and therefore the anode of D_2 will rise by the same amount, in fact the potential of D_2 anode will follow in sympathy with the output of the rectifier. When, however, an interference pulse is superimposed on the L.F. waveform the anode of D_2 cannot follow it closely as it is tied down by the 300 μF capacitor. The effect therefore is that instead of a sharp pulse of high amplitude being passed on to the L.F. amplifier, it has been integrated and is only slightly greater in amplitude than the L.F. signal at that particular moment.

Fig. 4 will give a good idea of the

*The Telegraph Condenser Co. Ltd.

effect of the limiter on interference pulses superimposed on an audio signal.

In use, the circuit of Fig. 4 works excellently, but it has been found to have a slight drawback under conditions of low input voltage to the detector.

When the input voltage to the detector is very low, severe distortion occurs, making sound unintelligible. This is due to D_2 cathode biasing D_1 cathode and so preventing rectification over a part of the cycle. Above some critical voltage no distortion occurs. The use of a lower value of cathode resistor such as 10 KΩ in place of 33 KΩ overcomes this difficulty, though at a slight reduction in detector efficiency.

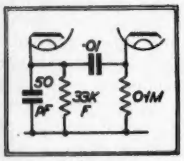


Fig. 5. Modified version of suppressor of Fig. 3.

A different method of obviating this distortion at low inputs is to couple the diodes by a capacitor instead of by direct coupling. (Fig. 5). The D.C. bias is thereby removed from the cathode of D_1 yet D_2 can still follow the L.F. waveform since its cathode in conjunction with C_2 will act to restore the D.C. level.

This modified circuit gives the correct values to use and can be recommended. It should be mentioned here that this circuit is similar to that used in the Pye post-war receivers and which has proved extremely effective. Murphy Radio have further modified the circuit of Fig 5* so as to give a constant ratio of signal to noise by arranging for the bias on D_2 anode to be taken not from a steady D.C. source but from the rectified audio output of the last amplifier valve, the mean anode current of D_2 thus varying according to the mean audio output. (Fig. 6.)

The great advantage of this system is that interference is suppressed according to the strength of signal and therefore on quiet passages the interference is almost inaudible, whereas with a steady D.C. bias on D_2 interference, though still suppressed, would be equal in strength on both loud and weak passages.

Though the limiting circuits of Figs. 3 & 5 have so far been shown immediately following a diode detector, they can just as easily be arranged to follow an amplifier, such as the triode section of a double-diode triode.

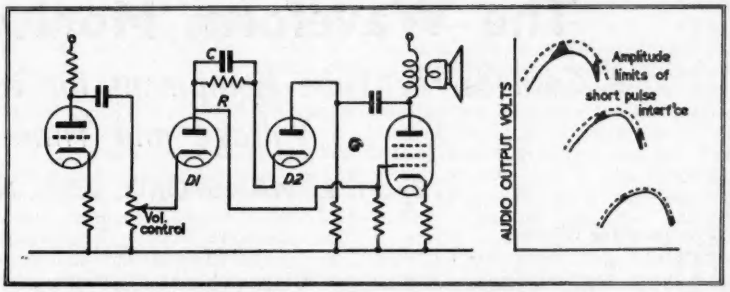


Fig. 6a. Murphy version of noise limiter to give constant signal/noise ratio.
Fig. 6b. How the Murphy noise limiter gives a constant signal/noise ratio, the limiting action depending on the audio voltage at any instant.

When this method is adopted it is important to remember that the audio stage should have a good frequency response. This limits the maximum gain obtainable from the stage, and an anode load resistance of about 15 KΩ is recommended.

Turning now to suppression in the vision receiver, it is found that the problem is to some extent easier. Experience has invariably shown that interference on vision is not as psychologically objectionable as that on sound, and because of this, the acceptable limit of interference is somewhat greater and conditions are not as critical.

This is fortunate, as it would not otherwise be easy to arrange for a limiter to follow the video waveform as it does the audio, due to the fact that the interfering signal may be identical in shape to any part of the video signal.

The obvious course is to limit the interference to the peak-white level, accepting it below this figure.

In practice, suppression of this type is very effective as only small white spots are visible on the screen, while without this limiting the cathode-ray tube is driven so far above peak white that the result is a mass of very large defocused blobs which tend to obliterate a large area of the screen.

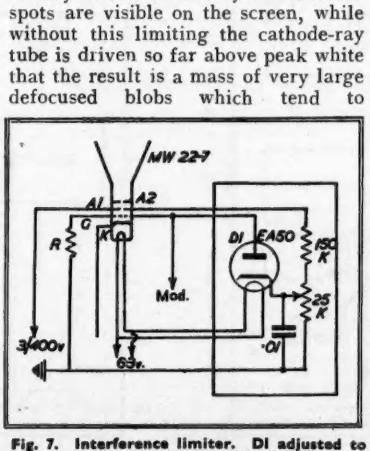


Fig. 7. Interference limiter. D1 adjusted to conduct above peak-white level.

A limiting diode may be connected across the video detector load resistance, but this is not recommended as adjustment is somewhat critical.

A better position in the receiver is to connect the limiting diode directly on to the grid of the cathode-ray tube. The circuit of a suitable amplitude limiter is that shown in Fig. 7, where it will be noted that all the connexions are taken direct on to the socket of the tube. In this case a Mullard MW.-22-7 C.R.T. was used, while the diode was a Mullard EA.50. The cathode-ray tube was grid modulated and fed by a cathode follower so that the small increase of capacity across this circuit is no way detracted from the quality of the picture.

In use, the 25 KΩ resistance is adjusted so that the diode conducts just above the peak-white level, the actual value depending on the contrast adjustment, it is not, however, critical and under normal conditions does not require readjustment over a wide range of contrast.

A more ambitious type of suppressor referred to by B. J. Edwards* is arranged to invert the interfering pulse and apply it to the tube in opposite phase so as to cut the tube off during the short period of the pulse. Instead, therefore, of having a white spot on the screen a black spot will appear in its place.

Whether black spots on the screen are to be preferred to white spots must be left to individual preference and only experience can prove this point. But with all the various methods of suppression adopted there can be no doubt that the most effective is that which prevents radiation at the source. It is to be hoped that one day the Government will give a thought to this matter and bring in legislation to overcome the problem finally.

* *Murphy News*, Oct. 1946—Pats. pending.

* J.I.E.E. Vol. 88, Pt. III p. 191.

The Waveform Monitor—Part 2

A Cathode-ray Tube Equipment for the Measurement of Voltage and Time

By H. L. MANSFORD, B.Sc., A.C.G.I.*

Synchronising Window

THAT part of the circuit referred to as the 'window' is again a 'long-tailed pair' behaving as that described in Fig. 2. It has been mentioned previously as serving three functions. These functions have been covered by the consideration given to Fig. 2. In the instrument illustrated, again a pentode valve circuit is used for the impedance Z_k.

Measurement of Signal Potential†

Because the instrument is A.C. operated, the isolation provided by the mains input transformer allows the D.C. potential of the circuits as a whole to be varied with respect to that of chassis, or earth. This feature, which is illustrated by Figs. 6a and 6b, enables any potential (represented by battery B) to be measured at Input 1 to be equalled by a change in the slider potential of the 'Y' shift potentiometer. In this way Input 1 potential, relative to the circuit potential, is returned to the balanced condition as indicated by the cathode-ray tube. The voltmeter M is first set to read zero at balance, with Input 1 at chassis potential. The change in the 'Y' shift potential, and therefore, the potential applied to Input 1, is indicated by the meter M.

The great advantage of such a "null" method is that readings are not affected by changes in amplifier gain or linearity or C.R.T. deflection sensitivity.

If the potential to be measured is required relative to some circuit potential different from that of the instrument chassis, this reference potential is supplied on a lead connected to the 'Reference Jack.'

The circuit shown external to the instrument is a simplification of that which is, for practical reasons, contained within.

Measurements are made in the same way with A.C. potentials, or a mixture of A.C. and D.C., at Input 1. With the waveform of Fig. 3, for instance, the 'Y' shift is first adjusted to bring the points A_1 D_1 to the balance potential, as shown by the horizontal cursor line before the cathode-ray tube screen, and the voltmeter reading is noted. A second balance is made with B_1 C_1 at the cursor. These two readings give the D.C. potentials of these points and the difference of the readings gives the amplitude A_1 B_1. A.C. coupling is available.

If the amplitude A_1 B_1 is large, when A_1 is brought to the cursor line B_1 will be off the top of the screen. On the G302 model of instrument, A_1 B_1 can be anything up to 250 volts before overloading starts to invalidate the voltage measurements. The use of the built-in 10 : 1 stepdown potentiometers for the measurement of higher voltages carries with it the disadvantage that the potential source is then loaded (4.5 MΩ and 25 μF. in this instrument).

To cover a range of voltage measurements, certain refinements are required. Fig. 6b gives greater detail. With the circuit of Fig. 6a and 1,000 volts across the 'Y Shift' potentiometer, potentials up to plus and minus 500 volts may be measured. Lesser potentials will be indicated by the meter M with less certainty, unless its range is adjusted to suit the particular case. Then, for small voltages, the adjustment of the slider position on the 'Y' Shift potentiometer would be most critical. With the modifications shown in Fig. 6b, a

* Electric Musical Industries, Ltd.
† British Patent Specification No. 515,044.

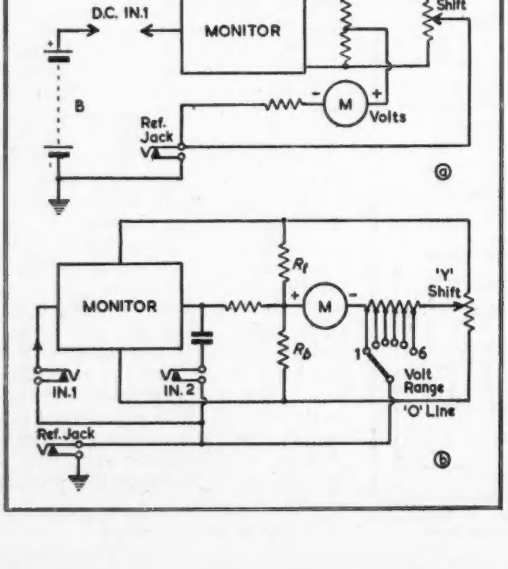
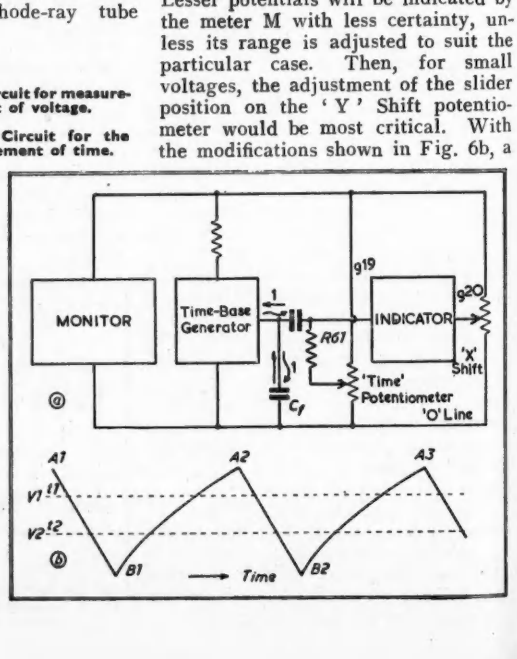


Fig. 6. Circuit for measurement of voltage.

Fig. 7. Circuit for the measurement of time.



full deflection either side of the centre zero of the meter M is provided by the full sweep of the slider of the ' Y ' Shift potentiometer. With the ' Volt Range ' switch on position 6, the main circuit potential may be raised or lowered by 500 volts. The switch position indicates the appropriate scale multiplier for the meter.

With the switch on position 1, only one-hundredth of this voltage is applied between the chassis and the main circuit. The meter indication is the same, but the new multiplier shown by the ' Volt Range ' switch is used in making the reading. Critical adjustment of the ' Y ' Shift is no longer necessary.

In addition, Fig. 6b shows how errors from the loading of the potentiometer $R_t R_b$ by the voltmeter current are eliminated by balancing the two inputs to the ' Y ' axis amplifier between ' Input 1 ' and the voltmeter.

The sensitivity of the indicator (controlled by ' Y Gain ') does not affect the balance.

Measurement of Time

Time may be measured in terms of an electric capacity, the value of a constant charging current, and the amplitude of the potential difference developed, from the formula:

$$Cv = it$$

A circuit is provided which maintains the current i at a constant value for a period. The capacity C may be given a series of known values. In this way a relationship is established between time and potential. A measurement is made of the potential change across a condenser, over a period, and this is interpreted as a time measurement.

The circuit of Fig. 7a shows a simplification in schematic form of that in the instrument, and Fig. 7b gives the potential waveform across the condenser (C_t). This same waveform is fed to one grid of a ' long-tailed pair ' forming the ' X ' axis amplifier. Capacity coupling is used to allow the mean potential of this grid to be controlled through the grid leak circuit and the setting of the ' Time ' potentiometer. At the frequencies considered, the impedance of this coupling condenser is very much lower than that of the grid leak (R_{g1}).

When there is no potential difference between the two grid inputs to the ' X ' axis amplifier, the C.R.T. spot shows at the position of balance behind the vertical cursor. A horizontal trace is produced when the second grid is earthy and the first is given the waveform of Fig. 7b. The spot is not visible during the period B_1 to A_2, as a negative pulse on the modulator of the C.R.T. interrupts the beam current.

If the mean potential of the first grid is changed by movement of the slider of the ' Time ' potentiometer, the trace moves longitudinally. At time t_1 a point v_1 on the trace waveform may be brought to the zero (cursor) of the indicator. If the potential of the slider of the ' Time ' potentiometer is now moved by an amount equal to $v_1 - v_2$ at a time t_2 a point v_2 will be brought to the zero of the indicator. The ' Time ' scale indicates t_1 and t_2. With ' Y ' axis deflecting potentials supplied to the C.R.T., v_1 and v_2 may represent salient points on the waveform.

It should be stressed that non-linearity in the indicator (C.R.T. and amplifier) characteristic sensivity does not affect the accuracy of the measurements, since the instantaneous condition of the C.R.T. and amplifier is the same, *i.e.*, balanced, when each reading is taken.

Working Circuits

In considering the ' Y ' axis amplifier, perfect linearity and balance of the valves and an accurately central undeflected spot on the C.R.T. were assumed. These conditions cannot be relied on in practice and centring of the spot on the cursor can only be achieved by some unbalance at the input to the amplifier, the amount varying with the unbalance in the valves.

Referring to Fig. 5b, this artificial balance is made by changing the potential of V_2 grid by moving the earthy end of R_{31}, relative to the main circuit. A small potentiometer gives this control and it is referred to as ' Y Zero.'

A further refinement is required to provide for the maintenance of balance with changes of ' Y Gain.' To meet this it is necessary that no potential difference should exist across the 'Y Gain' variable resistance under the balance condition, so that variation of the resistance value does not affect current flowing elsewhere. But owing to unbalance in the following stage (V_3 and V_4) or a badly centred C.R.T. electron gun, the balance condition may necessitate unequal currents in V_1 and V_2. In the separate cathode circuits of V_1 and V_2 (Fig. 5b) resistances are added with their junction at the positive side of Z_k. This junction point may be moved to give differential adjustment of the resistance included in each cathode circuit, so that with the required unequal cathode currents the voltages dropped across the two parts of this tapped resistance may be made equal. Fig. 5b shows these additions.

The setting up sequence is as follows:

(1) ' Y Gain ' is set to zero resistance, (maximum ' Y Gain ').
(2) ' Y Zero ' is adjusted with M at zero, to show balance.
(3) ' Y Gain ' is set to a maximum resistance (minimum 'Y Gain'.)
(4) ' Balance ' is adjusted to restore balance.

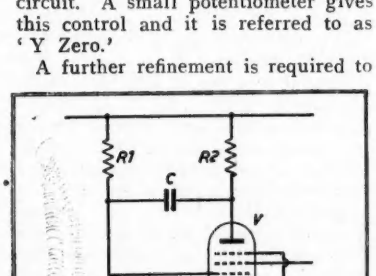


Fig. 8. Basic circuit for obtaining constant rate of change of potential during charge of condenser.

Timebase (sawtooth) Generator

The term ' timebase ' implies that the C.R.T. spot deflection—usually along the X-axis—shall bear a known relationship to the time spent, as measured from the start of the trace. The most convenient relationship for general use is a linear one, so that a constant rate of change of potential is required for the purpose of electrostatic deflection of the C.R.T. spot.

A constant rate of change of potential is provided across the terminals of a condenser if a constant charging current is flowing. A condenser with one side earthed may be charged by the current flowing in a resistance from a source of potential, (positive or negative). In such a circuit the current value decays as the condenser charges, because the potential across the resistance is the difference between that of the source and that of the charge. This gives an exponential relationship between potential and time. Probably the neatest circuit design to overcome this difficulty is shown in schematic form in Fig. 8. In this circuit* the potentials of both sides of the condenser are floating, and the current in the valve

* British Patent Specification, 580,527.

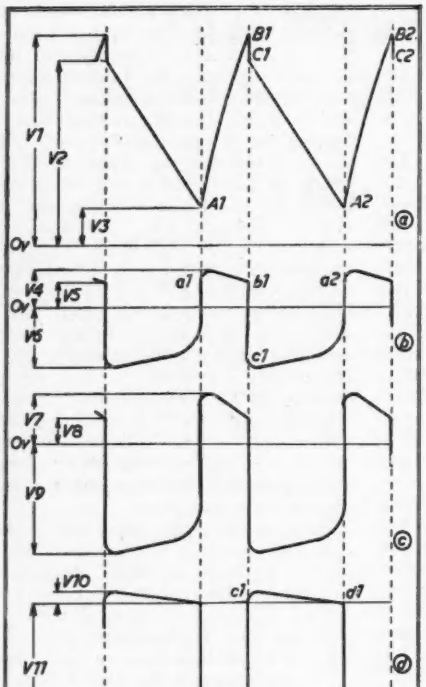


Fig. 9. Waveforms of potential across the electrodes of V.14 and V.17. (Fig. 10).

adjusts itself to move the potential of one of the condenser electrodes (the valve anode side) so as to maintain substantially constant the potential across the current limiting resistance r_1, while the charge potential increases.

Fig. 9 shows the waveforms of the potentials on the various electrodes of the valve, which is of the pentode or tetrode type. Assume that the working cycle is maintained by the provision of Fig. 9d waveform applied to the screen grid. During the period $A_1 B_1$ there is no screen grid potential, and little if any anode current flows. Current flowing in r_1 is drawn from the valve cathode, with the operating grid acting as a diode anode. This diode impedance is probably in the order of 1,000 ohms. Current flowing in r_2 can pass only into the condenser which is being charged as shown at $A_1 B_1$, Fig. 9a. This current also circulates in the grid-diode circuit to the valve cathode, adding to that already passing in r_1. The grid potential is shown at Fig. 9b, positive during the period AB by an amount dependent upon both the currents in r_1 and r_2. Because r_2 current value decays as C charges, the line $a_1 b_1$ inclines towards zero potential.

At time B_1 the screen grid is given positive potential which, with the control grid still positive and the anode potential well above the knee of the anode current/anode potential curve, gives momentarily a very large anode current far exceeding that flowing in r_2. This converts the charging of C into a discharge with a reversal of the direction of current flow. If the potential of the grid side of C were held, the high anode current would quickly discharge C, but in fact this potential is not held, and without discharging C anode and grid potential can only drop together. This occurs during the period $B_1 C_1$ which is very short; the time being governed by the valve anode current together with the anode and grid circuit capacities (strays to earth). The falling grid potential cuts down the anode current until the current flowing from C into the anode circuit equals in value that in r_1 (since the grid is now negative all the current in r_1 must flow into C). In this way the current in r_1 fixes the discharge rate from C and the valve adjusts its anode current to a value equal to that in r_2, which is variable with anode potential, plus that in r_1 which is the condenser discharge current.

The period is now that of $C_1 A_2$ (Fig. 9a). As C discharges the anode potential drops and the rate of dropping is substantially uniform because the potential across r_1, which fixes the discharge current, varies only by the amount necessary to change the grid bias on the valve, while the anode current adjusts itself to the changed requirments with the increase of potential across r_2. This gives the upward bend to the grid potential curve shown at $c_1 a_2$ (Fig. 9b).

The falling anode potential diverts more and more cathode current to the screen grid circuit, so making the cathode current increase faster than the anode current, until further increase is limited when the positive excursion of the grid is limited by the flow of grid current. The screen grid potential, which has passed through the period $C_1 D_1$ with a slight fall due to the current increase, must now drop again to zero in order to complete the cycle.

A pulsed screen grid potential was assumed for the purpose of explaining the working of the circuit of Fig. 8. A useful alternative which is possible with certain types of valve such as the VR91 and the VR65 or Z66, is to control the anode current by means of suppressor grid potential changes. A steady screen grid potential is then provided.

Practical circuits require additional valves in order that the control may be semi- or wholly automatic. Several of such circuits have been designed. The following explanation deals with one.

Referring to Fig. 10, valve V_{11} takes the place of that shown in Fig. 8.

Condenser C_f provides the sawtooth potentials. Resistance R_{120} has been added between the current fixing resistance R_{119} and the condenser C_f; its value is 1,000 Ω, and its purpose is to provide bias for V_{14}.

Referring again to Fig. 9, but this time associating the potentials with those in the circuit of Fig. 10, the period of the cycle A_1 and B_1 may be considered first. V_{17} has no bias; actually its grid is positive (ref. a_1 b_1). This we have seen is partly due to the charging current in C_f, which in the new circuit has two paths, either through R_{120} to the grid of V_{17} or through R_{107} to V_{14} grid. R_{107} is given the same value as R_{120}, and serves to limit the positive grid swing on V_{14} by a division of the condenser charging current between the two valves. Because V_{14} is passing current, V_{18} has bias from the potential across R_{106}. V_{14} anode and V_{18} cathode potentials are low enough to cut off current in V_{15} and V_{16}. Valve V_{17} therefore has no screen grid potential, which is as required for the period A_1 B_1.

Assuming V_{18} anode is connected to 1 on switch S_{10}, there comes a time when V_{17} anode potential has risen high enough, as C_f charges, to allow V_{18} to conduct and so to reduce V_{14} screen grid potential. V_{14} anode potential rises, carrying V_{16} grid positive also, so that V_{16} cathode follows with V_{17} screen grid, and V_{17} passes some current to the anode. With V_{17} passing current, the current in C_f reverses which reverses the current in and the potential across R_{120}, and supplies some negative bias for V_{14}. Consequently the reduction in V_{14} current continues in spite of the return of the screen grid potential to normal.

The anode potential of V_{17} is falling, B_1 C_1; the grid potential of V_{17} is also falling, b_1 c_1; but the anode drop is greater than that of the grid because of the reversal of potential across R_{120}. The potential fall at V_{14} grid (Fig. 9c) is that of V_{17} anode (they are coupled by C_f, less the potential which was developed across R_{107}. When V_{17} has set its grid potential to give the discharge current determined by R_{119}, the additional bias provided by the drop in R_{120} biases V_{14} to cut off all anode current. Its anode potential rises until limited by the current in V_{18}. This fixes V_{17} screen grid potential also. The potentiometer feeding V_{18} and V_{16} grid potentials is made up of both resistance and capacity elements in order that the frequency range of the circuit

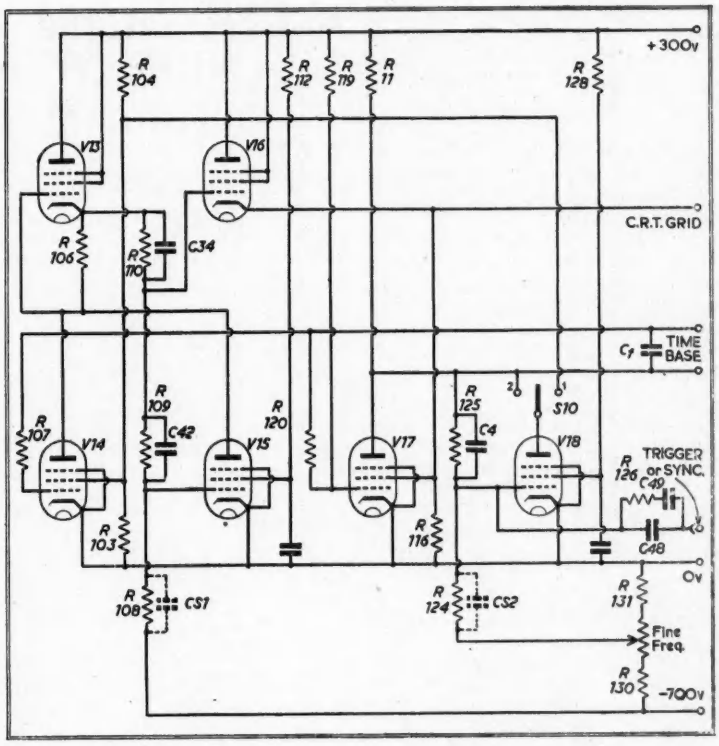


Fig. 10. Practical form of circuit using the principles described.

shall not be limited by circuit capacity, as would be the case if resistance elements only were used.

The period of the cycle is now C_1A_2 (Fig. 9a). V_{17} anode potential falls to A_2, that is until V_{17} cannot maintain the discharge current and is in grid current. The bias on V_{14}, which was reduced with that on V_{17}, is now reduced by the removal of the R_{120} potential. This sets V_{14} anode current to its maximum again so that V_{17} loses its screen grid potential. The cycle is now complete.

Frequently it is more convenient to have provided a time base generator giving only one sweep for each triggering pulse, which may or may not have the waveform of the signal to be viewed on the C.R.T. screen. The circuit so far described is self triggering. A control for the repetition rate of the cycle is necessary in order to achieve synchronisation between the time base and the signal to be viewed. The 'Fine Frequency' control (Fig. 10) is a potentiometer which by control of the mean bias on V_{18}, gives a control of the upper limit to the excursion of V_{17} anode potential, and so controls the duration of both the charge and discharge times for C_f. If S_{10} is switched to position 2 the feed-back path is broken and the circuit remains quiescent at the point B on the potential cycle (Fig. 9e). V_{14} is in grid current and passing anode current. V_{17} is in grid current but passing no anode current, as it has no positive screen grid potential. V_{17} anode potential is held by the current passing in V_{18}.

The circuit may conveniently be triggered at V_{18} grid because V_{18} ceases to pass current when the trace starts (period C_1 A_2), so preventing any interference with the trace potential by the triggering potentials; which may otherwise spoil the linearity of the trace waveform. Condenser C_{49} has a capacity value comparable with the strays CS_2, and R_{126} in series with the large condenser C_{49} forms a resistance element effectively in parallel with R_{124}. The potentiometer at V_{18} grid has therefore three arms, each giving one control to the grid potential. These are: (I) That from the anode of V_{17} through the

potentiometer R_{125} to R_{124} in parallel with R_{126} at low frequencies, replaced by C_4 to CS_2 in parallel with C_{48} at high frequencies. (II) That at 'Fine Frequency Control,' which does not change the ratio of the potentiometer, but by controlling the mean bias on V_{18} fixes the upper limit to the swing of V_{17} anode potential. (III) That at Trigger or Sync. which comes from the 'window' circuit and works through R_{120} into R_{124} and R_{125} in parallel at low frequencies, with C_{48} working into C_4 and CS_2 in parallel at high frequencies.

With switch S_{10} on position 2, and the circuit quiescent, the sequence of triggering is as follows:

V_{18} grid potential is raised by current fed from 'Trigger or Sync.' The increase of current in V_{18} flowing in R_{11} lowers V_{17} anode potential. There is negative feed-back to V_{18} grid which reduces the impedance and possibly the potential swing at this point. The fall in V_{17} anode potential is communicated to its grid by the coupling by C_7. V_{16} grid shares this drop in potential so that its anode current is reduced, V_{15} receives less bias, and V_{16} a positive grid swing. This gives screen grid potential to V_{17} and the cycle is started.

The method used for triggering the circuit with switch S_{10} on position 2, is also effective as a means of synchronising the time base when S_{10} is on position 1, and the circuit is self triggering. Then the positive synchronising potential at V_{18} grid serves to advance the time at which this grid reaches the triggering potential.

Each side of C_7 connects to one grid of a long tailed pair of valves forming the 'X' amplifier. One other output from the circuit is taken from V_{16} cathode, where the waveform and output impedance provides a suitable drive for the grid of the C.R.T. in order to brighten it only during the "working" stroke $C_1 A_2$.

The circuits which have been described give a survey of the type of circuits used in Admiralty Waveform Monitor Type G302. In this instrument the frequency response of the 'Y' amplifier provides for a pulse time of rise of 0.15 μsecs., a maximum 'Y' deflection sensitivity of 10mm/volt, and a maximum writing speed of 10 cms./μsec.

An improved model, to operate from 50 cycle mains, is in course of development at the E.M.I. Research Laboratories.

A Note on the Zero Setting Circuit of the Waveform Monitor

By A. M. SPOONER, B.Sc.

WHEN measuring small potential differences of the order of a few volts by the method shown in Fig. 5b, a difficulty is encountered in that current flowing in the voltmeter alters the current distribution in the potentiometer $R_1 r_1 r_2 R_2$, with the result that the potential of the control grid of V_2 is modified and incorrect readings are obtained on the meter. It would be possible to minimise the effect by (a) using a sensitive microammeter for the voltage readings and/or (b) allowing a large current to flow through $R_1 r_1 r_2 R_2$, but these two expedients are undesirable since in the case of (a) the meter becomes very fragile and (b) is wasteful of H.T. supply current and results in the generation of unnecessary heat. The meter used normally takes about 1 mA and the current through $R_1 r_1 r_2 R_2$ is 5 to 10 mA.

The required condition is that the difference of potential between A and B shall be set by the "Y zero" potentiometer such that the cathode-ray tube spot or line is centred on the screen with zero current through the meter, and that subsequent deflection of the meter in reading an applied voltage between the input grids or between one grid and earth, shall leave the potential between A and B unaffected. Thus, if $r_1 = r_2$ and all the complementary parts of the system between the control grids of V_1 and V_2 and the screen of the cathode-ray tube are balanced, the wiper of the "Y zero" potentiometer will have to be in the middle of its track for zero cathode-ray tube deflection with no applied signal. The "Y zero" potentiometer has a high resistance value compared with r_1 and r_2. The voltage across r_1 and r_2 is 2 to 4 volts, this being sufficient to cope with any normal variations in components.

The error in the voltmeter reading may be divided into two parts, (a) a negative error proportional to the reading and (b) an error which may be positive or negative and varies with the position in which it is necessary to operate the "Y zero" potentiometer. The error (a) has a value $i\left(\frac{r_1 r_2}{r_1 + r_2}\right)$ where i is the meter current, *i.e.*, the meter behaves as if a resistance equivalent to r_1 and r_2 in parallel were connected in series with it. The error may easily be overcome by reducing the meter multiplier resistance by $\frac{r_1 r_2}{r_1 + r_2}$.

Elimination of the error (b) occurs if R_1 is made equal to R_2 (with $r_1 = r_2$), but this is not always possible since the ratio of R_1 to R_2 decides the potential of the control grids of V_1 and V_2 relative to the H.T. supply, and it is not usually convenient to operate these grids tapped exactly half-way down the supply. Replacing r_1 and r_2 shunted by the "Y zero" potentiometer by a low value centre tapped potentiometer, eliminates all error when the wiper is at the centre of its track, but an error is introduced progressively as the wiper is moved to either end.

The best method of eliminating the error (b) is to retain the circuit as shown in Fig. 5b and to make $r_1/r_2 = R_1/R_2$.

Under these conditions it may easily be shown that the component of error introduced by movement of the zero setting potentiometer is completely cancelled.

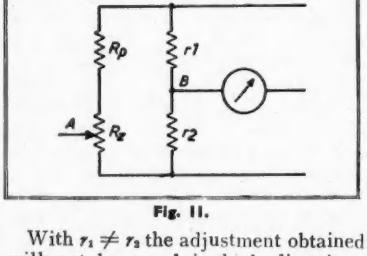
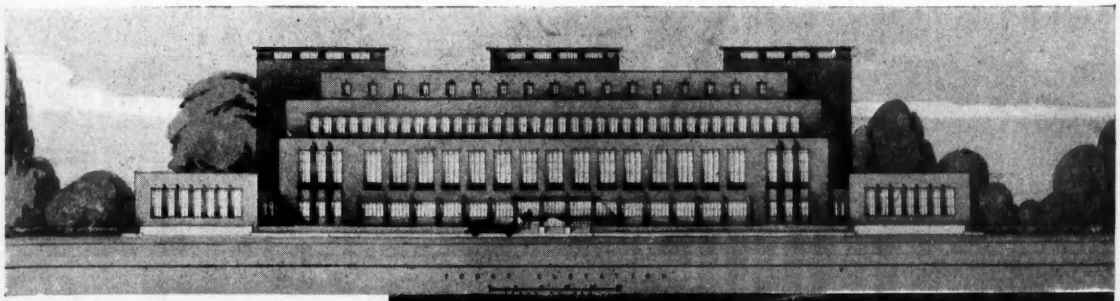


Fig. 11.

With $r_1 \neq r_2$ the adjustment obtained will not be equal in both directions and a padding resistance should be inserted in series with the "Y zero" potentiometer. Fig. 11 shows the modified circuit, in which R_p is the padding resistance. For equal voltage swing in both directions on the zero setting potentiometer R_z

$$\frac{R_p}{R_z} = \frac{r_1 - r_2}{2r_2}$$

for the case given in the diagram, in which $r_1 > r_2$. If $r_1 < r_2$ then r_1 and r_2 change places in the above expression, and the padding resistance is inserted on the other side of R_z



The Future of Electrical Research

INCORPORATED in 1920, the British Electrical and Allied Industries Research Association has proved to be one of the most successful of the co-operative Research Associations under the aegis of the Department of Scientific and Industrial Research. The value of its work is recognised, not only by its members but also by a much wider circle of industrialists and men of affairs.

So great have been the demands made upon its existing facilities at the Perivale Laboratory, that these are no longer adequate if the Association is to keep abreast of its obligations to the electrical industry. Accordingly, the E.R.A. Council has decided that the time has come to seek more spacious premises for the Association's activities. A suitable site has now been obtained at Leatherhead, Surrey, and plans for new laboratories to be built there have been approved by the Council and by the Department of Scientific and Industrial Research on behalf of the Government. The new project will involve large capital expenditure and an appeal for financial support is shortly to be made to the electrical industry. A Government grant of up to one-third of the total cost of providing the new buildings and equipment has been promised provided that the industry contributes no less than two-thirds as capital. It is clearly the responsibility of the industry to accord the greatest possible support to this project, so as to entitle the Association to make the maximum demand upon the Government grant. If the electrical industry of this country is to maintain its high position, it is imperative that its co-operative research facilities should be commensurate with the present-day needs and future possibilities of the industry.

Front elevation and panoramic view of the proposed new E.R.A. Laboratories, *with acknowledgments to Mr. H. J. Rowse, F.R.I.B.A., the architect.*

View of the Bank crossing during the installation of the traffic lights. Note the checked vehicles at the centre and cross traffic to the south.

Automatic Traffic Control at the Bank

ONE of the most complicated traffic junctions in London was brought under the control of automatic signalling in July last, when the Automatic Telephone & Electric Co. installed "Electromatic" equipment to the specification prepared by the Ministry of Transport and the City of London Police.

The difficult and complex layout of the junction is seen from the photograph above.* In addition, the approaches are narrow and the junction handles no less than 35,000 vehicles in each 12 hours. Another point of importance is that the intersection is in the line of several main traffic routes running east and west and north and south through the City.

For this reason the most recent development, known as "Biassed Linking" was applied to interlink the Bank crossing with several adjacent intersections and thus form a complete scheme.

Principle of Vehicle Actuation

The basic principle of vehicle-operated traffic control is shown in the circuit diagram† in which the fundamental timing is accomplished by the usual capacitor-charging circuit VRA-CA. Across the capacitor is a neon discharge lamp FA in series with a relay coil A. The capacitor charges at a rate determined by the value of the resistor VRA. A vehicle approaching the junction closes the contacts X through pressure on the actuating pad in the road. The condenser then discharges through the relay coil A and the lamp FA, which in turn operates a solenoid to change the lights in favour of the vehicle.

If, however, a vehicle is passing over the crossing at right angles to the first one, it will close contacts Y and discharge the condenser through the 2,000 ohms resistor before X is operated. The lights will thus continue in favour of the second vehicle until the condenser has had time to charge up again.

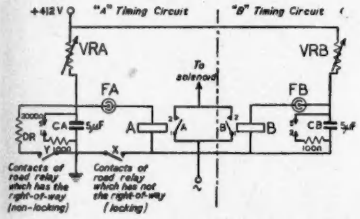
It is possible that the time spacing

* Overseas readers will be interested to note that a bomb hit the exact centre of this junction during the raids of 1941, wrecking the Underground booking hall below.

† *see* T. P. Preist "Electrical Control of Road Traffic by Vehicle Actuation," J.I.E.E. Vol. 77, p149, 1935.

between successive vehicles in one direction will be less than the time taken to charge the condenser, in which case the relay A will never have a chance to operate and the lights will remain permanently in favour of one stream of traffic.

The time of operation of the contacts Y is therefore limited by an auxiliary circuit, the "B" timing circuit shown, which is established when the contacts X are closed. The capacitor CB then charges and operates the solenoid through the relay B, unless the original circuit "A" has come into action. When this happens, the movement of the solenoid automatically discharges CB through the contacts S2.



Principle of vehicle-operated traffic control
—from Preist's paper, J.I.E.E.

These two circuits perform all the timing functions of the traffic control system. The charge interval of capacitor CA is equivalent to the time required for the vehicle to cross the intersection; each operation of the contacts Y is equivalent to the passage of succeeding vehicles across the detector pad; finally the charge interval of B is equivalent to the predetermined interval of time for which a continuous stream of traffic may hold waiting cross traffic.

"Biased Linking"

With biased linking, vehicles receive individual consideration as described above, but in addition a special reservation is introduced into the timing which can be described as a "right to priority" period. This period is one during which normal traffic control is in operation, but the particular through traffic has a special priority right which overrides the claims of cross-road vehicles and prevents them changing the lights in their favour. The priority period is introduced into the timing cycle at each intersection and in successive stages of timing according to the main progressive plan.

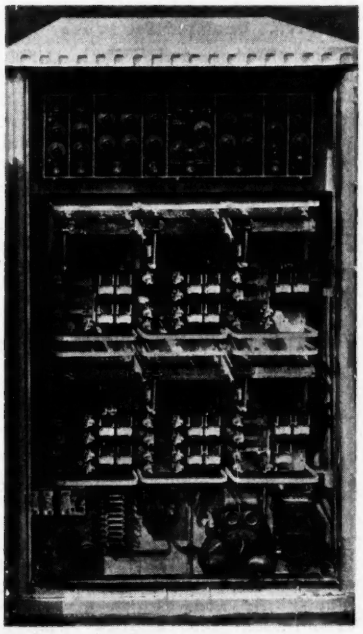
In the usual co-ordinated system it may happen that the traffic, having crossed one intersection, encounters a red signal at the next.

The biased linking so arranges the timing that if each traffic group is travelling at the correct speed it will arrive at each intersection within the "right to priority" period and so secure a green signal. As this special period is only introduced as one section of the complete timing cycle, there is no undue penalising of cross-traffic and one or more blocks of main traffic are kept moving at constant speed without delay at the intersecting roads.

Special arrangements are made at the Bank whereby in certain cases right-of-way time not used by one approach during any cycle may be used by a second approach. The pairs of approaches having this facility are:

Threadneedle Street and Cornhill, Queen Victoria Street and Poultry, Lombard Street and King William Street.

If there is no demand on Threadneedle Street, then traffic on Cornhill is permitted to have right-of-way during the time which was allotted to Threadneedle Street and can retain right-of-way for the whole length of the two periods provided for these two approaches in the cycle. Similar conditions apply to each pair.



Interior of one of the control pillars showing relays.

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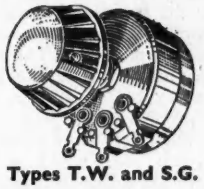

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Sutherland Road, Higham Hill, Walthamstow, E. 17
Telephone: Larkswood 3245

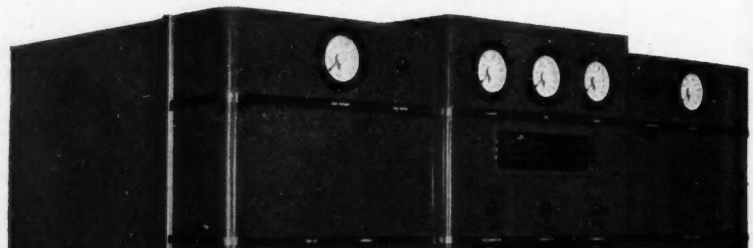
NOTES FROM THE INDUSTRY

The Philips R.F. Heating Equipment

The Philips Type FV.100 radio-frequency generator illustrated here will produce up to 54 KW of energy in the work at a frequency of 350 Kc/s. Additional frequencies of 400, 700, and 1,000 Kc/s. are available by a tap-charging system, enabling the load to be accurately matched with widely varying volumes of metal.

A prominent feature is the continuous variation of output current by means of a variable step-down transformer between the valve anode and the tank circuit. All controls are grouped in front and remote control can also be used. An electronic timer ranging from 0.2 to 10 secs. is incorporated.

The circuits are interlocked to ensure correct operating sequence and the whole apparatus is fully protected with circuit breakers and fuses. The standard model is suitable for 380-440 V. 3-p.h. 50 c/s. Further details are obtainable from Philips Electrical, Ltd., Century House, Shaftesbury Avenue, W.C.2.



Aerial Coaxial Connector

The new Burgoyne coaxial cable connector provides an efficient means of making a watertight connexion between the cable and aerial and will also serve as the centre insulator for a half-wave doublet. The casting is of aluminium with steatite insulation for the eyebolts, and a tube of weatherproof cement is supplied for serving the joints after assembly. The price is 24s. 6d., which is not high for a workmanlike substantial component. Sole distributors: M.O.S. Ltd., 24 New Road, E.1.

Correction

British Mechanical Productions Ltd.

In "Notes from the Industry" in the September issue of this journal we inadvertently published a reference to the Clix B9G valveholders under the heading of "General Accessories Co." Clix radio and television components are, of course, manufactured by Messrs. British Mechanical Productions, Ltd., of 21 Bruton Street, London, W.1. The General Accessories Co., Ltd., are associates of British Mechanical Productions, Ltd., and are electrical wiring accessory manufacturers.

P.V.C. Insulated Set Wires

The Rubber and Plastic Cable Division of Standard Telephones and Cables, Ltd., have issued a useful leaflet on their P.V.C. insulated set wires. Suitable for the internal wiring of radio, telephone and other electrical equipment, the wires can be supplied in a wide range of colours, and three thicknesses of insulation. The address of the Rubber and Plastic Cable Division is Corporation Road, Newport, Mon.

War Diary of the English Electric Co., Ltd.

One of the best-produced war records we have seen to date is that of the English Electric Co., Ltd. A substantial volume, well bound in dark blue, it contains in a concise and lucid style a survey of the Company's principle activities from March 1, 1938, to August 14, 1945. The diary is well illustrated throughout, and at the end a section is devoted to D. Napier & Son, Ltd., of which organisation the English Electric Company took control on December 23, 1942.

New Switches

Lists Nos. 280 and 282 introduce new ranges of "Memrex" and "Memajor" switches and switch fuses, which comply with the requirements of BSS. 861 and 88/1939.

Among the new features of these switches are:

Removable switch bar to facilitate wiring.

Improved shielding.

Provision for neutral terminals in 3-pole switch fuses.

Prices and discounts are available on application to Midland Electric Manufacturing Co., Tyseley, Birmingham 11.

The Miles Electric Actuator

This unit, designed by Miles Aircraft, Limited, can supersede the air control systems using hydraulic, pneumatic or mechanical methods for operation of the many components on the modern aircraft.

A small electric motor is used to drive a multi-stage epicyclic gear, the final stage of which operates a quick acting screw thread at a greatly reduced speed which varies according to the performance for which the

actuator is designed On the thread is located a hollow piston with a similar internal thread which is prevented from turning, but is free to travel longitudinally in a metal housing. Consequently, when the motor is in operation, the piston has to travel along the screw thread in either direction according to the rotation of the motor, increasing or decreasing the overall length of the actuator and operating the connected component in the desired direction.

All components except the actual piston are enclosed in concealed housings, the piston sliding in a dust- and moisture-proof screen at the derangement from the increase of oil from the engine installation.

Although the actuator is primarily developed for the operation of aircraft control, it can be adapted to perform any function requiring linear or rotary motion, and can be arranged to give visual indication of its operation by means of a warning lamp.

Miles Aircraft, Limited, (Actuator Division) are at present producing a wide range of electric actuators covering a field from 20 lb. to 1,000 lb. thrust in linear models and from 8 lb./in. to 120 lb./in. torque in rotary types.

Degrees for Ex-Service Men

Mr. O. S. Puckle writes:

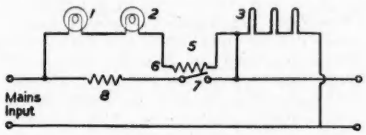
"With regard to my previous correspondence in connexion with degree courses for ex-servicemen and those engaged in industry: The results of the inquiry have been sent to the Ministry of Education, who have handled the matter sympathetically. They are communicating with the local councils concerned with a view to the provision of classes at times more convenient for those members of the staff of firms who cannot be released for day-time attendance except on Saturday mornings. It must be realised, however, that the final responsibility for the organisation of courses rests with the individual teaching establishments.

It is hoped that suitable arrangements can be made in time for the forthcoming winter sessions, but it is regretted that it is only in certain parts of the country that the numbers of applications are sufficient to permit of any action being taken.

I would like to thank those who have helped by filling in my questionnaires and to apologise for being perhaps able to assist only a portion of them to obtain suitable courses."

The Protection of Dial Lamps in a Universal Receiver

In a "universal" or A.C.-D.C. type of receiver, dial lamps and pilot lights are commonly connected in series with the filament or cathode heater circuits of the apparatus. This gives rise to the disadvantage that the cathode heaters, having a low resistance when cold, allow a comparatively high surge of current to flow in the series circuit thereby endangering the pilot lamp filaments. If a pilot lamp filament "blows" while the receiver is in operation, a further disadvantage becomes evident, for then the receiver immediately ceases to operate.



In order to remove these disadvantages the accompanying circuit has been devised. It operates so that the dial lamp and pilot light filaments are shunted by a closed relay contact 7 during the initial warming-up period. At the end of this period the delayed thermal relay 5 operates to open the contact so that the dial lamp filaments are then placed in the valve filaments 3. As by this time valve filaments are hot, however, their resistance is sufficiently high to prevent damage to the dial lamps by excessive current.

In the event of an open circuit in the filaments of the dial lamps 1 and 2 the valve heater supply is momentarily stopped. The thermal relay 5 then cools to allow contact 7 to close, completing the circuit by way of resistor 8 and contact 7 to the filaments 3, and the receiver comes back into operation. So that the receiver shall continue to operate with the same current flowing in the valve filaments of the dial lamps 1, and 2 and and the heater 6 of the thermal relay 5.

—Communication from E.M.I. Laboratories.

MEETINGS

Institution of Electrical Engineers

All meetings of the London Section will be held at The Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

Radio Section

Date: October 15. Time: 5.30 p.m.
Inaugural Address as Chairman.
By: C. E. Strong, O.B.E.
The Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Cambridge and District Group

Date: October 21. Time: 6 p.m.
Held at: The Cambridgeshire Technical College.
Chairman's Address: "Further Education for the Engineer."
By: R. W. Wilson, B.Sc.(Eng.)
Secretary: J. E. Curran, University Engineering Laboratory, Trumpington Street, Cambridge.

Institute of Physics

London Group

Date: October 16. Time: 5.30 p.m.
Held at: The Middlesex Hospital, Medical School, Mortimer Street, London, W.1.
Lecture: "Electrical Phenomena in Living Tissue."
By: W. A. Floyd, F.Inst.P.
The Secretary, The Institute of Physics, 47 Belgrave Square, S.W.1.

Electronics Group

Date: October 7. Time: 5.30 p.m.
Held at: The Royal Society, Burlington House, London, W.1.
Lecture: "Electronic Calculating Machines."
By: Professor D. R. Hartree, F.Inst.P., F.R.S.
Secretary: A. J. Maddock, "Sira," Southill Road, Elmstead, Chislehurst, Kent.

The Television Society

Convention at Radiolympia

A Convention of the Society, to which all interested are invited, will be held at Olympia on October 7, 2-5 p.m. in the National Hall Gallery.
Subjects:
Home Constructed Television.
Television as Entertainment.
Television Production.
Full particulars can be obtained from the Convention Secretary: Mr. A. E. Sarson, Cinema-Television, Ltd., Worsley Bridge Road, S.E.26.

The British Sound Recording Association

Date: October 24.
Lecture: "Sound Recording as applied to Broadcasting."
By: M. J. L. Pulling, M.A.
Secretary: R. W. Lowden, 3a Pembroke Buildings, Camberley, Surrey.

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BOOK

Electronic Control of Resistance Welding

389 pp. 173 figs. British price 22s. 6d.

Electronics in Industry

461 pp. 292 figs. British price 25s.

Both by G. M. Chute.
(McGraw Hill)

Mr. Chute is one of the writing fraternity of the (American) General Electric Company, but his books do not merely advertise GE products (and some others), as a superficial glance might suggest; they assist in building a practical outlook by describing actual equipment besides general principles, and in considerably more detail than usual.

These manuals of practice have been developed from evening classes for operators and servicemen of little initial knowledge. Maintenance of interest supersedes orderly classification, new topics being introduced as required. No tube knowledge is assumed and little mathematics is used, the author supplementing rather than duplicating other texts. Chapters are short but plentiful, forming easy stages for study, and summaries, cross-references and footnotes are freely used.

The first volume deals in great detail with the *control* problems of resistance welding, the actual metallurgical process being only briefly mentioned. Section I, Ignitron Contactors, Tubes and Weld Timers, introduces spot and seam welding, ignitrons v. magnetic contactors and the importance of timing. Ignitron "know-how" leads to advice on installation and maintenance of the simple ignitron contactor, including vibration effects, close proximity of go- and return-cables, discharge resistor, cooling, and starting difficulties. The intricacies of ignitron ratings, per cent. duty and load sharing are clearly treated. Servicing instruments include the "pointer-stop" ammeter and CRO. Tube time-delay relays and thyratrons precede automatic weld timers and pulsation or interrupted spot welding which can handle exceptionally thick pieces. GE and Weltronic timers are described. A maintenance and "trouble-shooting" chapter discusses the effects of voltage supply, tubes and relays, surges, resetting time, ambient temperature and relay checking. Good voltage supply is essential because of short-cycle heavy loading, and valuable information follows on cable sizes, transformers and capacitor correction.

The importance of precise timing for quality welding in steel and for welding at all in brass, stainless steel, aluminium, etc., requiring operations of only 1 or 2 cycles or even less, and the effects of reactance on transients, lead to Part II, Synchronous Control of A.C. Welding. Synchronous timing, exactly in step with the A.C. voltage wave, demands electron-tube control to start at the right point of the wave, giving also precise duration of welding current. Timing, control and firing are illustrated by various commercial equipments. Excellent advice on starting, maintenance, etc., includes 17 informative case histories. Seam welding equipments of timing-chain and all-tube types are followed by a combined seam-spot-pulsation welder. Finally, series-capacitor P.F. correction of welders is discussed.

Part III covers Energy-Storage Welding, used partly for certain materials such as aluminium alloys and particularly for reduction in maximum power demand. Capacitor and reactor (Sciaky process) storage are explained in theory and practice, with various analogies, concluding with polyphase rectification as used in GE control.

"Electronics in Industry" covers the whole field of industrial control fairly adequately. Some elementary material parallels the earlier book, but there are original ideas such as the "ideal" tube curves (page 52) where anode current is unchanged by anode volts, closely approached by tetrodes and pentodes. Useful general references including textbooks are given on page 2. Actual tube behaviour is said to occupy only 1/5 of study time, the rest on external circuits. Three types of circuit diagram—elementary, connexion and schematic—are used throughout, but British readers will regret the use of the confusing American industrial symbols.

Applications cover thyratron heating, dimming and ½-cycle magnetising control, motor control, voltage and speed regulators, high frequency (including inverters and oscillators) and electronic heating, servos for temperature recorders, light relays and register controls. Regulators of welding voltage and current and resistance welding are briefly dealt with, but one especially interesting chapter discusses *arc* welding control by servo motors controlled from the actual arc voltage. "Thymotrol" motor control shows assembly progress strikingly by comparing the improved back panel view on page 346 with Fig. 141 of Cockrell's "Industrial Electronic Control" (1944), to which this reviewer took exception.* Electronic service instruments and auxiliaries such as the peaking transformer, saturable reactor, constant-voltage transformer, selsyn, thyrite, metal rectifiers and thermal devices conclude this book, except for an impressive list of visual aids (technical films and film-strips), arranged against chapters. It makes good reading and begs for similar facilities in this country. Many chapters include problems, mostly of the "true-or-false" type, answers actually being given at the back of the book.

Throughout the text the author builds up a solid and smoothly written back-

* *Electronic Engineering*, October, 1945, p. 741

REVIEWS

ground to each subject, which should give the student confidence. Subjects are first explained broadly, then in detail, forming an object lesson for many would-be authors. Those who welcome the enlivening of technical subjects will note the reference to vacuum tubes as the " white-collar " or professional class in their inability to handle large currents while exercising fine control, whereas vapour tubes are termed " brawn " or labouring class. Electrons are " bashful " in ordinary air. Further personality is possessed by " boy scout " tubes, watchful guardians in motor control, and " snubbers " who limit armature current. Thyratrons also resemble " mousetraps " and pliotrons " water-faucets." This colouring is not excessive, however, and does not replace important explanations.

The first book, on the need and methods for precision resistance welding, and the second, a solid record of general industrial electronic equipment, should both be read by production engineers as well as personnel. Although addressed only to users, prospective designers and research engineers will discern and appreciate the liberally scattered small but vital operating details which distinguish the *art* of electronic engineering from its purely scientific basis.

J. C. FINLAY

Telegraph Transmission Theory

By E. H. Jolley (Pitman, London). 124 pp. 53 figs. Price 7s. 6d.

This booklet is intended for the less advanced students of telegraphy and the subject-matter is part of a comprehensive textbook which is in course of preparation. The mathematical level in the main text is reduced to the minimum consistent with accurate explanation but, for the more advanced students, a twenty page appendix of mathematical proofs is included.

As an introduction the most important C.C.I.T. definitions relating to telegraph transmission are discussed. The theory of the transmission of direct current signals over lines is then considered with particular reference to the current build up time in various networks and the maximum speed of working. The general principles of alternating current transmission are then presented but it should be noted by the reader that although the reasons given on page 39 for closing a transmission line with its characteristic impedance are correct, from a consideration of the signal-noise ratio, not discussed in the booklet, transmission lines, particularly coaxial cables, are frequently left " unterminated." The relations between the steady state and transient conditions are considered and the use of distortion correcting networks is demonstrated. The section on electric wave filters is very concise and for the benefit of interested students a short bibliography of works using the insertion loss as a basis for design could have been included . The various types of multi-channel carrier telegraphy are described and in conclusion the permissible distortion for long distance working is considered.

This booklet is well written and should be most useful to students of telegraphy. That it has been prepared with great care is shown by the fact that the only error found is an obvious printers error on page 122.

F. G. CLIFFORD.

The Microscope : Its Theory and Applications

J. H. Wreddon, F.R.M.S., (J. & A. Churchill Ltd. 296 pp. 298 figs. 21s. net.)

According to the author's preface, this book is written not only to provide general information about the theory and construction of the microscope but also to set down a number of more unorthodox applications and processes which the author has developed as a result of constant use of the instrument.

The book contains a short but very interesting historical introduction by W. E. Watson-Baker, and chapters on elementary optics, the compound microscope, the eyepiece, the objective, substage condensers, illumination, the polarising microscope, photomicrography, and the preparation of specimens. The theory and construction of the instrument is fully described and illustrated, although it is a pity that most of the half-tone illustrations of microscopes and accessories are taken from the catalogue of one manufacturer.

Any reader, however, who is interested in unorthodox applications will be disappointed with this section of the book, which is meagre and contains little unorthodox or new. It seems extraordinary that a text-book on the microscope can appear in 1947 and contain no reference to the most important development of the last decade—the phase contrast microscope.

On the other hand, oil lamps are dealt with at some length but the ribbon filament lamp, which is used today for almost all photomicrography, is just mentioned but not described. The spelling of the Pointolite lamp varies in places, and there are a number of other spelling errors and inaccuracies which have been overlooked in the proof reading.

The book is well produced, but it cannot be felt that it makes a new contribution to the existing literature on the subject.

R. M. WESTON.

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ABSTRACTS OF ELECTRONIC LITERATURE

TELEVISION

Television High Voltage R.F. Supplies
(R. S. Mautner and O. H. Schade)

Constructional features of two typical units are shown and their performance is illustrated by curves indicating the magnitudes of current and voltage obtained under typical operating conditions. Sample calculations for the specific cases of a 75 watt, 90 kilovolt supply and a 10 watt, 30 kilovolt supply are included to illustrate the progressive steps in designing and calculating the circuit elements and operating conditions for a specified performance. A table of the symbols used is included at the end of the paper.

—*R.C.A. Review*, March, 1947, p. 43.

Film Projectors for Television
(R. V. Little, Jr.)

Television will make wide use of 35-mm. and 16-mm. motion picture film. The method of televising motion pictures using the storage-type pickup device is described. Theatre and television projection practice are compared and methods of meeting proposed RMA Television Standards are discussed. Recently designed 16-mm. and 35-mm. RCA television projectors are described in detail.

—*Jour. S.M.P.E.*, February, 1947, p.93.

Colour-Television Transmitter for 490 Megacycles
(N. H. Young)

A television transmitter, developed to specifications of the Columbia Broadcasting System, is described. It radiates colour-television signals at a carrier frequency of 490 megacycles per second with a power output of approximately 1 kilowatt.

—*Electrical Communication*, Vol. 23, No. 4. December, 1946, p. 406.

CIRCUITS

Electro-Encephalograph Amplifier
(D. L. Johnston)

An amplifier with frequency response of 0.15-10,000 c/s. is described, it requires a 15 μV peak-to-peak input signal for full output drive, and operates on A.C. supplies without batteries by an extension of the technique of electronically-stabilised power supply circuits. The overall mains-frequency hum signal is equivalent to less than 0.5 μV peak-to-peak input signal. Four channels of amplification and an ink-writing recorder are assembled in a compact equipment for electro-encephalography. Some special properties and unusual circuit arrangements of differential amplifiers are discussed. Critical balancing adjustments have been eliminated by the use of degenerative circuits.

—*Wireless Engineer*, August, 1947, p. 231.

A High-quality Recording Power Amplifier
(K. Singer)

The subject of this paper is an amplifier which will be used primarily as a power amplifier in recording channels. It is capable of driving light modulators as, for instance, galvanometers or disk recorders. It is intended to be used also as a monitor amplifier to supply power to loudspeaker installations for small monitor rooms.

—*Jour. S.M.P.E.* Vol. 48, June 1947. p. 560.

Electronic Switch for the Production of Pulses
(C. R. Smitley and R. E. Graber)

Circuit provides variable pulse lengths, variable pulse rate, variable delay of synchronising pip, and a means for introducing a steady-state signal upon which pulses may be superimposed, in a generator designed for laboratory use.

—*Electronics*, April, 1937, p. 128.

The Ratio Detector
(S. W. Seeley and J. Avins)

A new circuit for F.M. detection known as the ratio detector is coming into wide use. In this circuit two frequency-sensitive voltages are applied to diodes and the sum of the rectified voltages held constant. The difference voltage then constitutes the desired audio frequency signal. This means of operation makes the output insensitive to amplitude variations.

The basic principles governing the operation and design of the ratio detector are described. The ratio between the primary and secondary components of the frequency-sensitive voltages in a phase-shift type of ratio detector is a function of the instantaneous signal amplitude. The amplitude modulated rejection properties, however, are shown to depend upon the mean ratio between these voltages. An expression which is developed for this ratio in terms of the circuit parameters provides the basis for arriving at an optimum design. The measurements necessary in the design of a ratio detector and in checking its performance are described.

—*R.C.A. Review*, Vol. 8, June, 1947. p. 201.

Predetermined Counters
(J. J. Wild)

Banks of ten-position switches permit setting electronic counter decades to actuate a relay after any desired total count. Industrial uses include batching, counting, timing, controlling zipper-making machines, and automatic packaging of pills.

—*Electronics*, March, 1947, p. 120.

THERMIONIC DEVICES

Miniature Tubes in War and Peace
(N. H. Green)

This paper describes the design features which account for the versatility and lower cost of the miniature tube and cites several varied applications of miniatures in both military and commercial equipment. A table showing typical present-day applications for miniature tubes is included.

—*R.C.A. Review*, Vol. 8, No. 2. June, 1947, p. 331.

A Magnetron for D.C. Voltage Amplification
(H. B. G. Casimir)

In this article the magnetron is discussed as an amplifier valve. It is found that the magnetic sensitivity of a magnetron, which plays a part analogous to the amplification factor of a triode, can be considerably increased by introducing a grid at cathode potential close to the anode. As an example the employment of such a magnetron with grid is described in an X-ray apparatus where a regulator triode, at a very high voltage, had to be fed by a weak D.C. voltage signal given by a regulator at earth potential.

—*Philips Technical Review*, December, 1946. p. 361.

Coaxial Tantalum Cylinder Cathode for Continuous-Wave Magnetrons
(R. L. Jepsen)

Major factors affecting the design of cathodes for continuous-wave magnetrons are considered. A particular type of structure, the coaxial tantalum cylinder cathode, is analysed in some detail and its merits and shortcomings discussed. An approximate method is developed for computing optimum geometry and maximum life. Application to a particular magnetron is described and other applications suggested.

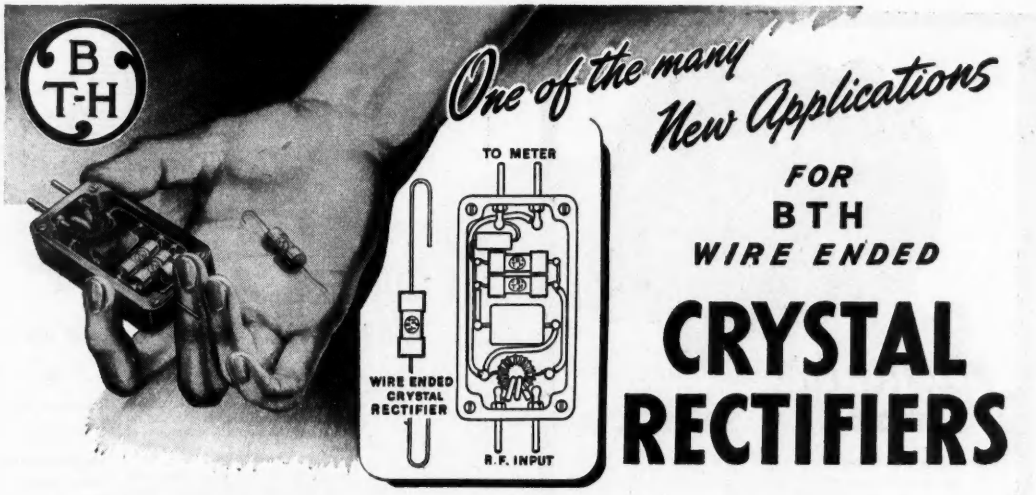
—*R.C.A. Review*, Vol. 8. No. 2. June, 1947. p. 301.

Triode Amplification Factors
(J. H. Fremlin, R. N. Hall and P. A. Shatford)

After a brief discussion of the theoretical formulae available, the paper describes some experimental results which were obtained to assist design work with grids of high shadow ratio. Tables are given from the formula, shown experimentally to be the best, for convenient use in calculating amplification factors for valves using such grids.

Theoretical and experimental results showing the effect of abnormally close electrode spacings are also described. Valves using parallel plane electrodes are alone considered.

—*Electrical Communication*, Vol. 23, No. 4. December, 1946, p. 426.



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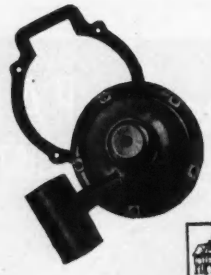

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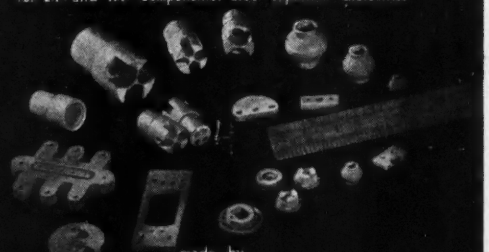

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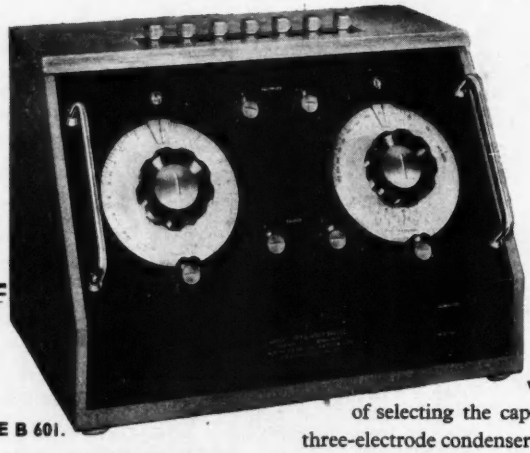

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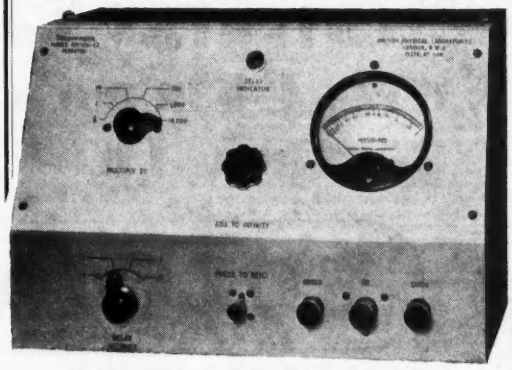

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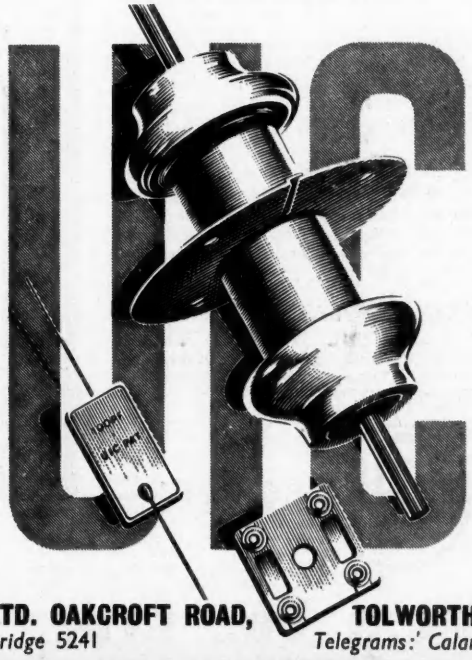

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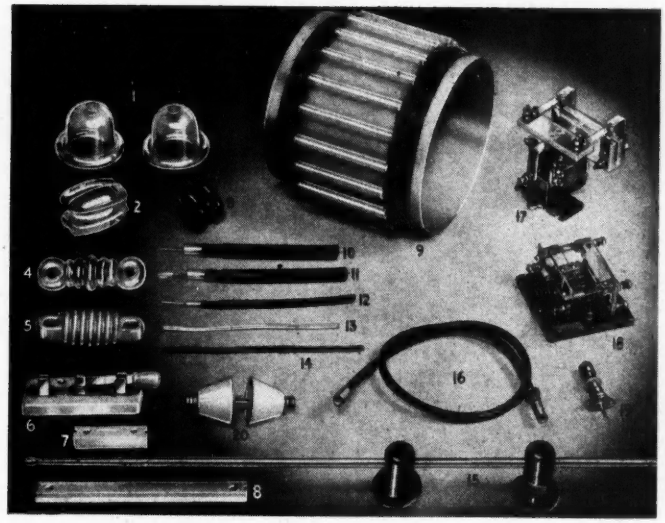

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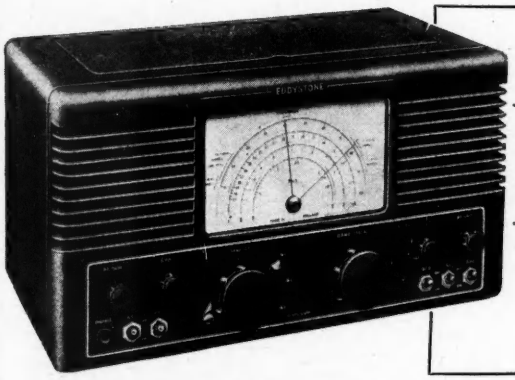

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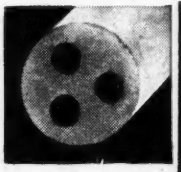

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Alloys specially recommended for Radio Production

ALLOY Tin/Lead	Equivalent B.S. Grade	MULTICORE Colour Code	Solidus °C	Liquidus °C	Recommended bit temperature	USES
60/40	K	Red	183	190	230°C	High quality work requiring low melting point alloy
45/55	M	Crimson/Buff	183	227	267°C	Hand soldering, Radio, Telephone and Electrical Equipment - Batteries
40/60	C	Green	183	238	278°C	

STANDARD GAUGES

Ersin Multicore Solder can also be supplied in any intermediate size

Standard Wire Gauge	Diam. in Inches	Diam. in M/ms.	Approx. Number of feet per lb. ALLOY 60/40	45/55	40/60
10	0.128	3.251	25.2	23.5	23.0
12	0.104	2.642	38.1	35.2	34.9
13	0.092	2.337	48.7	45.3	44.5
14	0.080	2.032	64.4	59.2	58.6
16	0.064	1.626	100.5	94.3	92.1
18	0.048	1.219	178.5	167.8	163.5
19	0.040	1.016	257.5	240.4	235.5
20	0.036	0.914	318.0	302.5	291.0
22	0.028	0.711	526.0	492.0	481.0

SIZE 1 CARTONS

High Tin 60/40 Tin/Lead Alloy

Catalogue Ref. No.	S.W.G.	Approx. length	List Price (Subject) s. d.
C 16014	14	4½ ft.	6 0
C 16018	18	11¼ ft.	6 9

Standard 40/60 Tin/Lead Alloy

Catalogue Ref. No.	S.W.G.	Approx. length	List Price (Subject) s. d.
C 14013	13	27 ft.	4 10
C 14016	16	60 ft.	5 3

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